Fundamentals of Asset Management

Step 8. Optimize Capital Investment

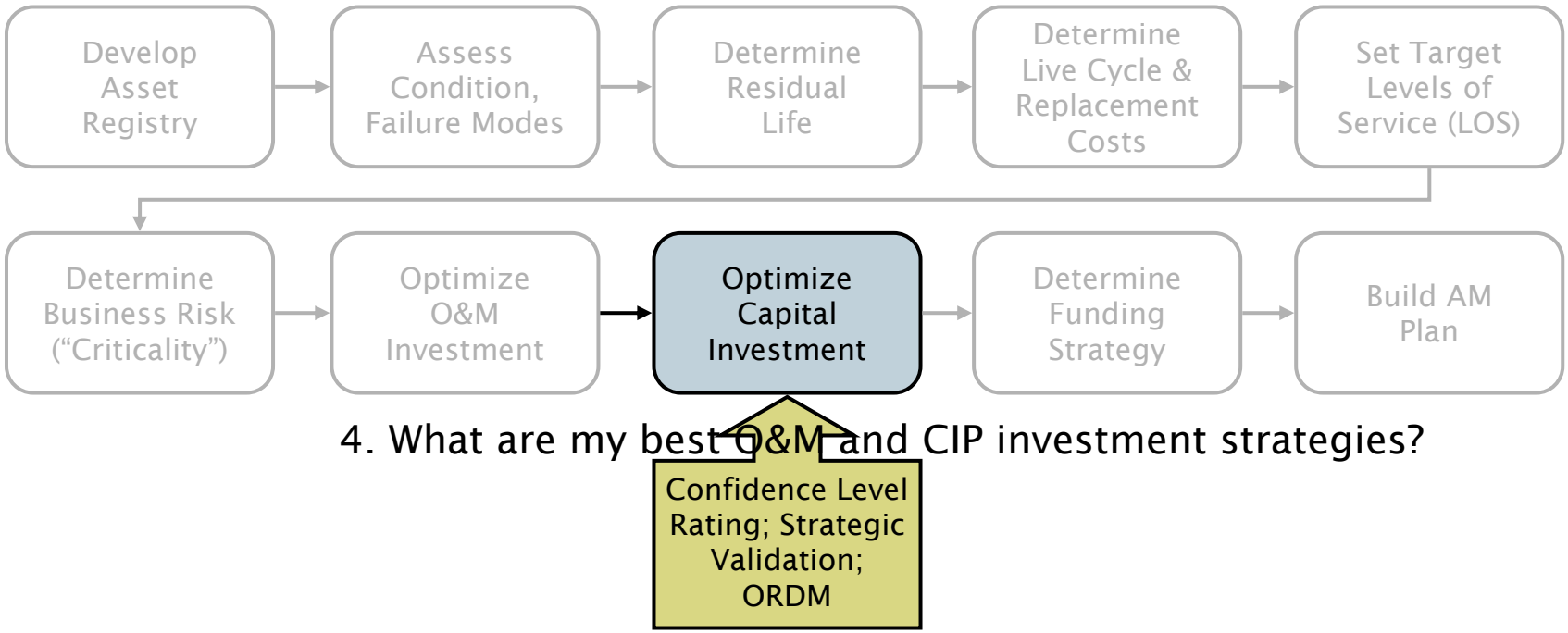
A Hands-On Approach

Tom’s bad day…

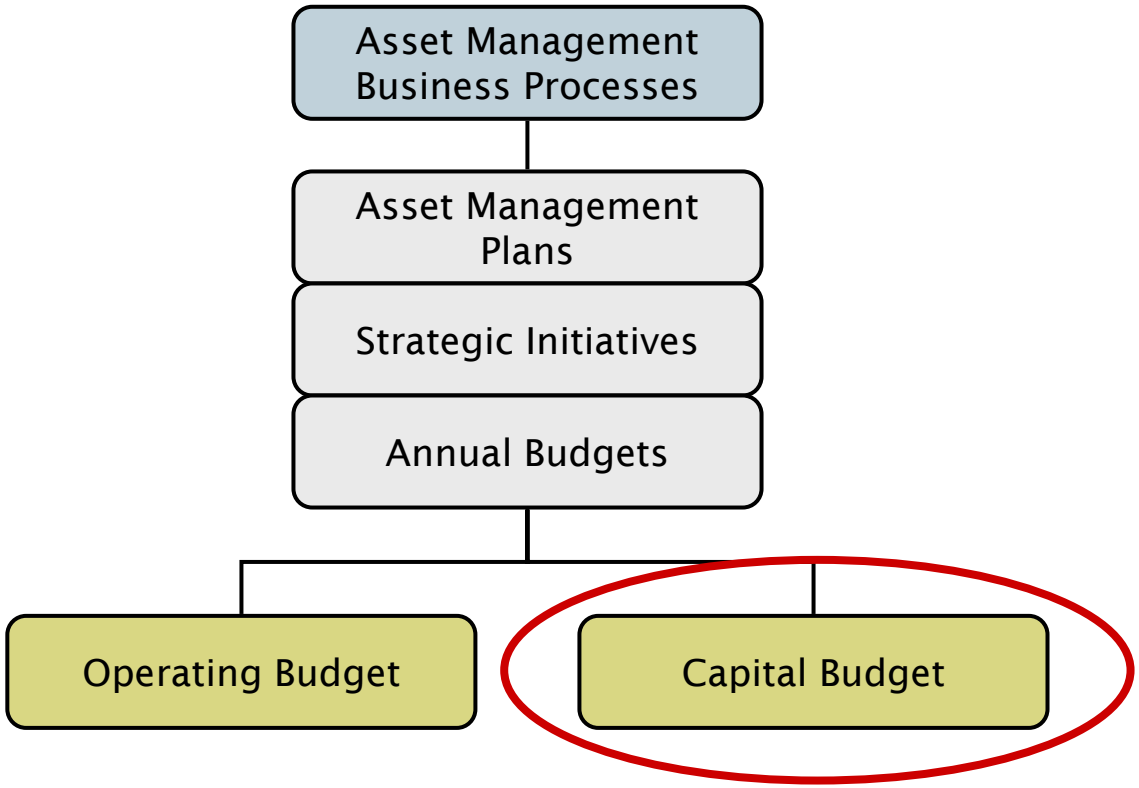
Fourth of 5 core questions

4. What are my best O&M and CIP investment strategies?
   - What alternative management *options* exist?
   - Which are the *most feasible* for my organization?

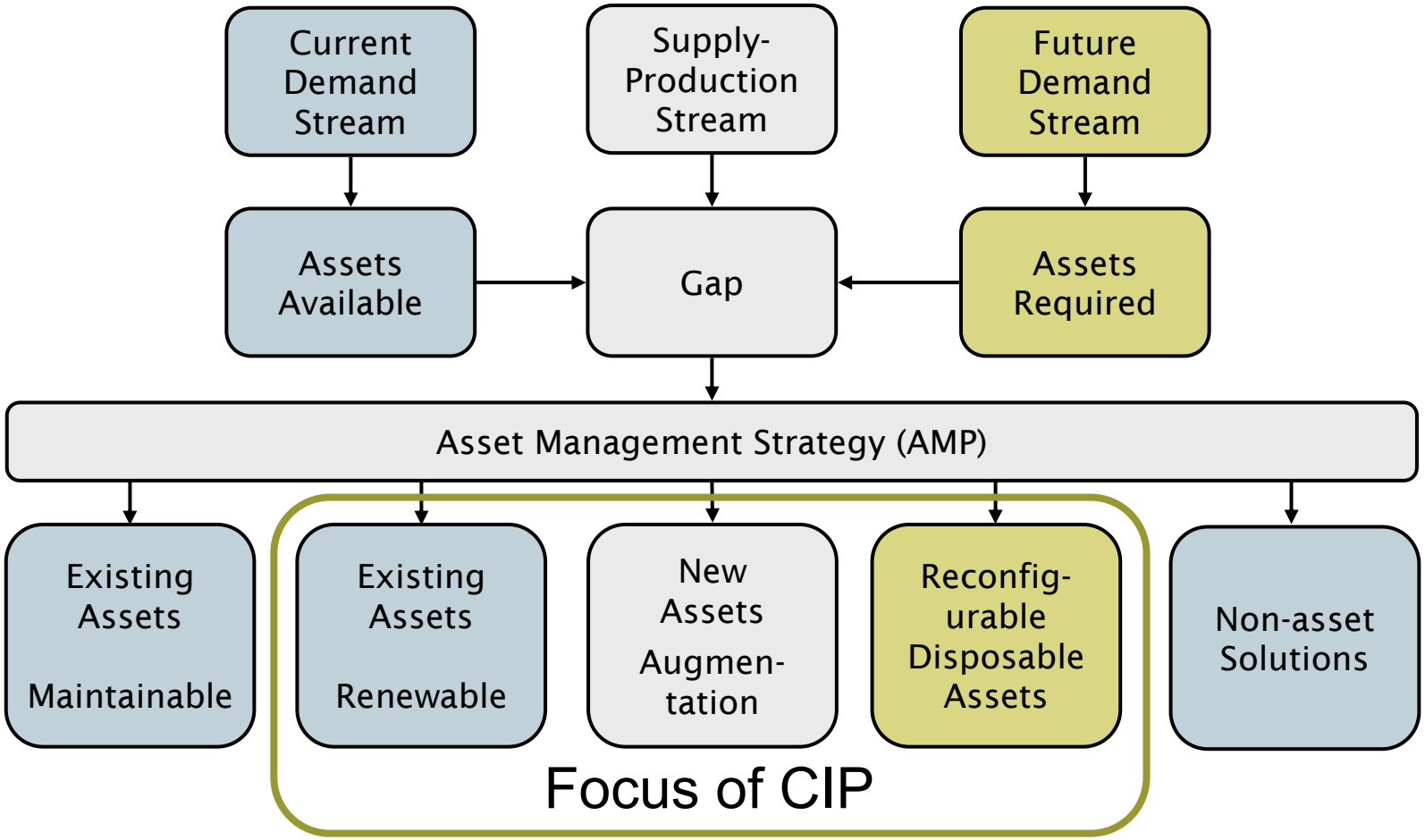
AM plan 10-step process



Recall view 4: Management framework



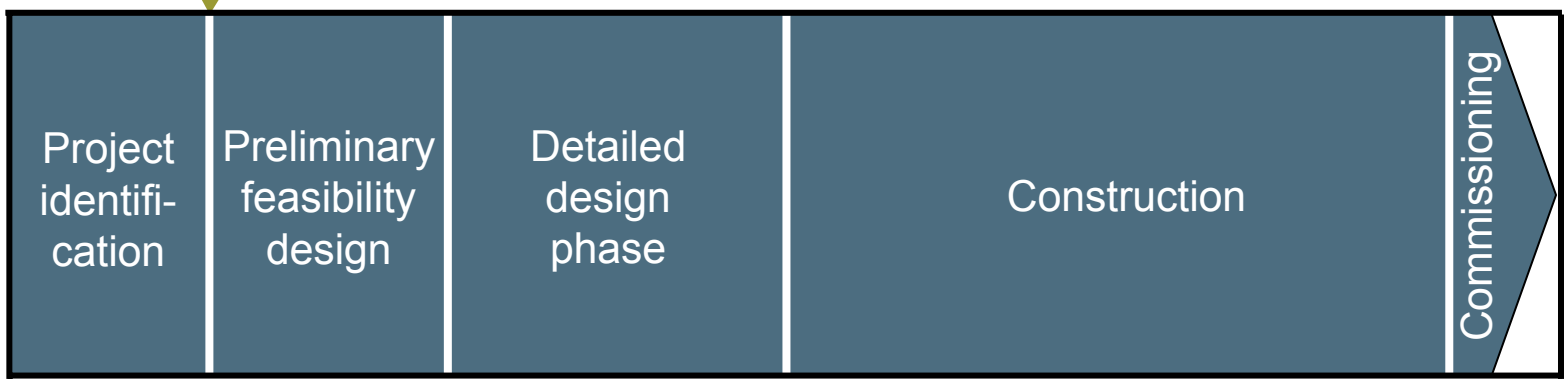
Balancing future demand with current capabilities



The CIP process *locks* in life cycle costs!

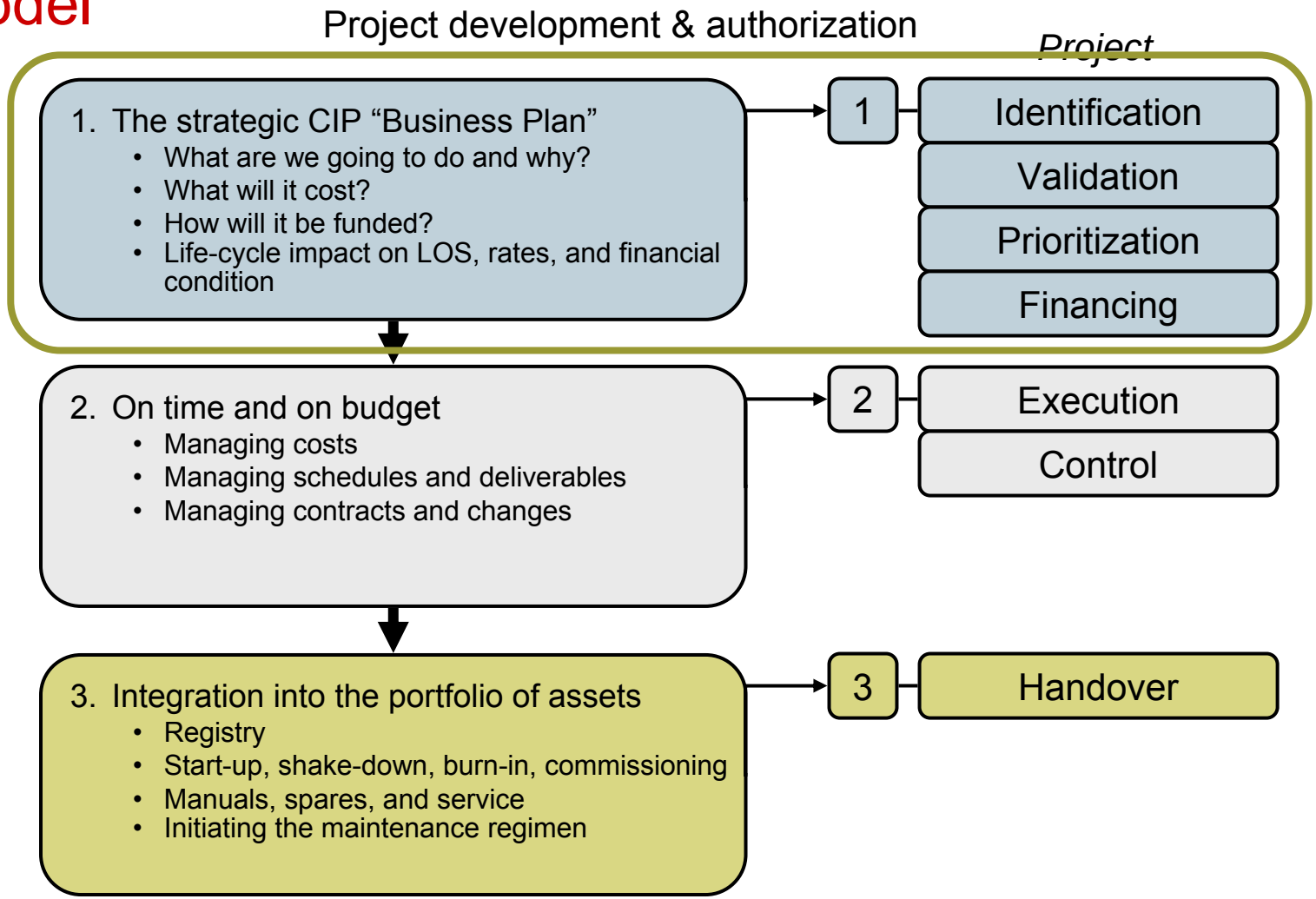
65-85% of all life-cycle costs are "locked-in" here!

Life-cycle O&M costs often are 5-10 (even 20) times initial construction costs

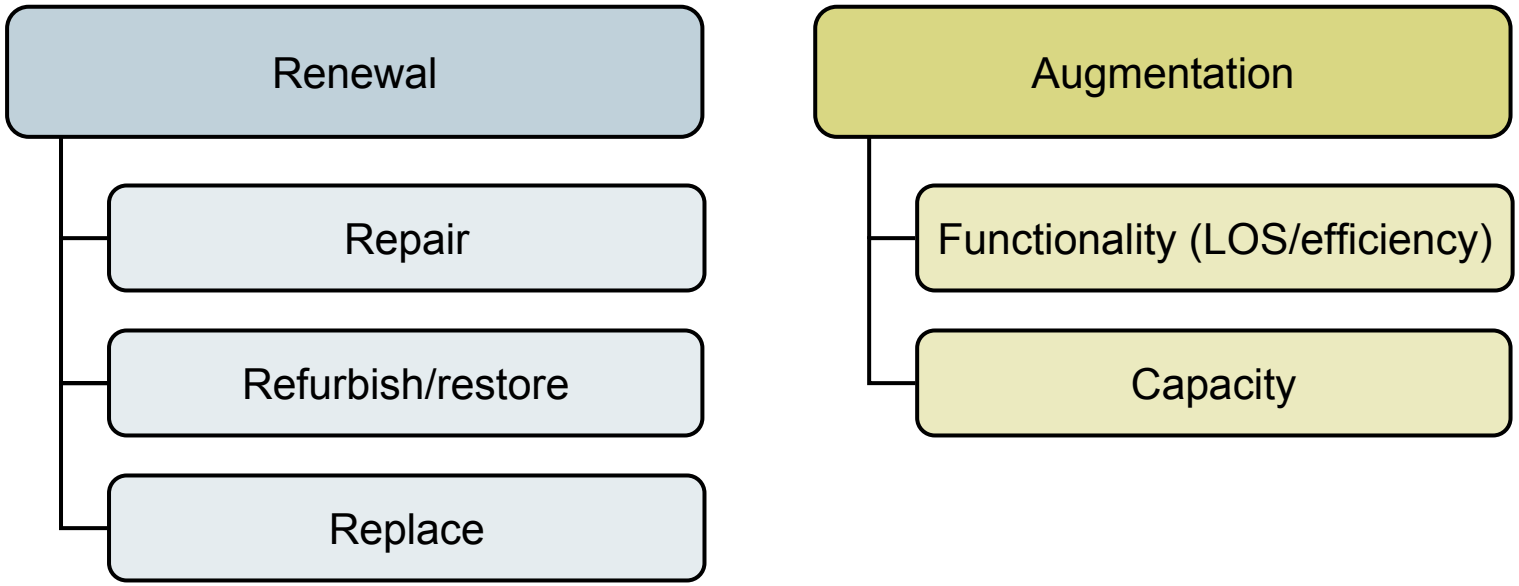


Life-cycle cost reduction opportunities diminish →

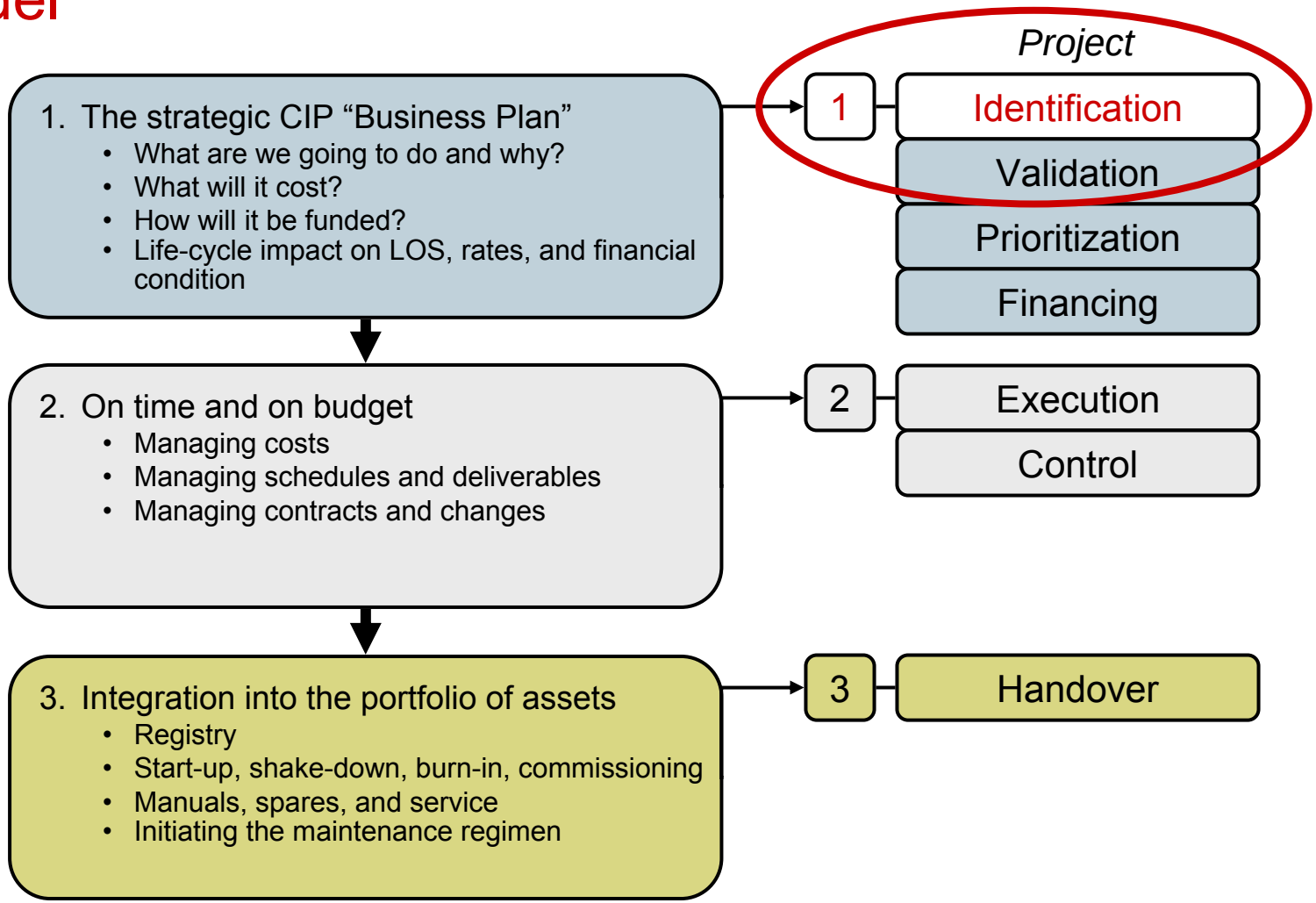
Deriving the CIP investment program – a best practice model



Capital investment is made up of two major types of projects



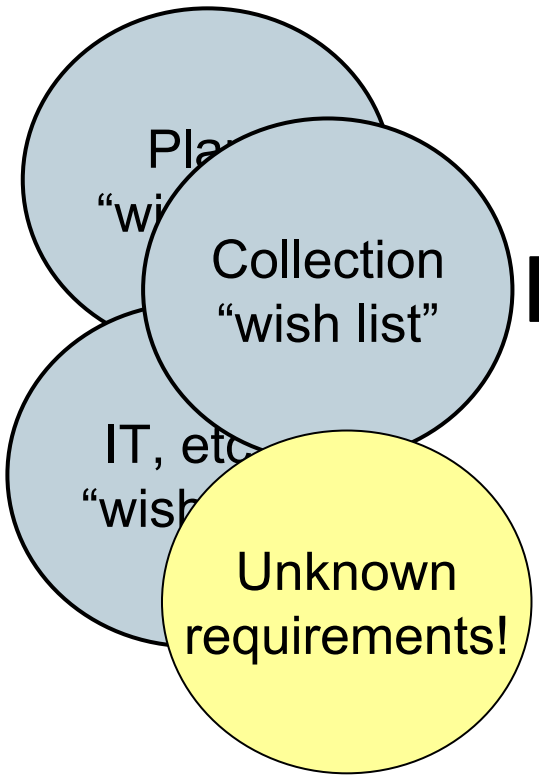
Deriving the CIP investment program – a best practice model



Project identification: Moving to “best practice”

“Champion” model

“Structured” model

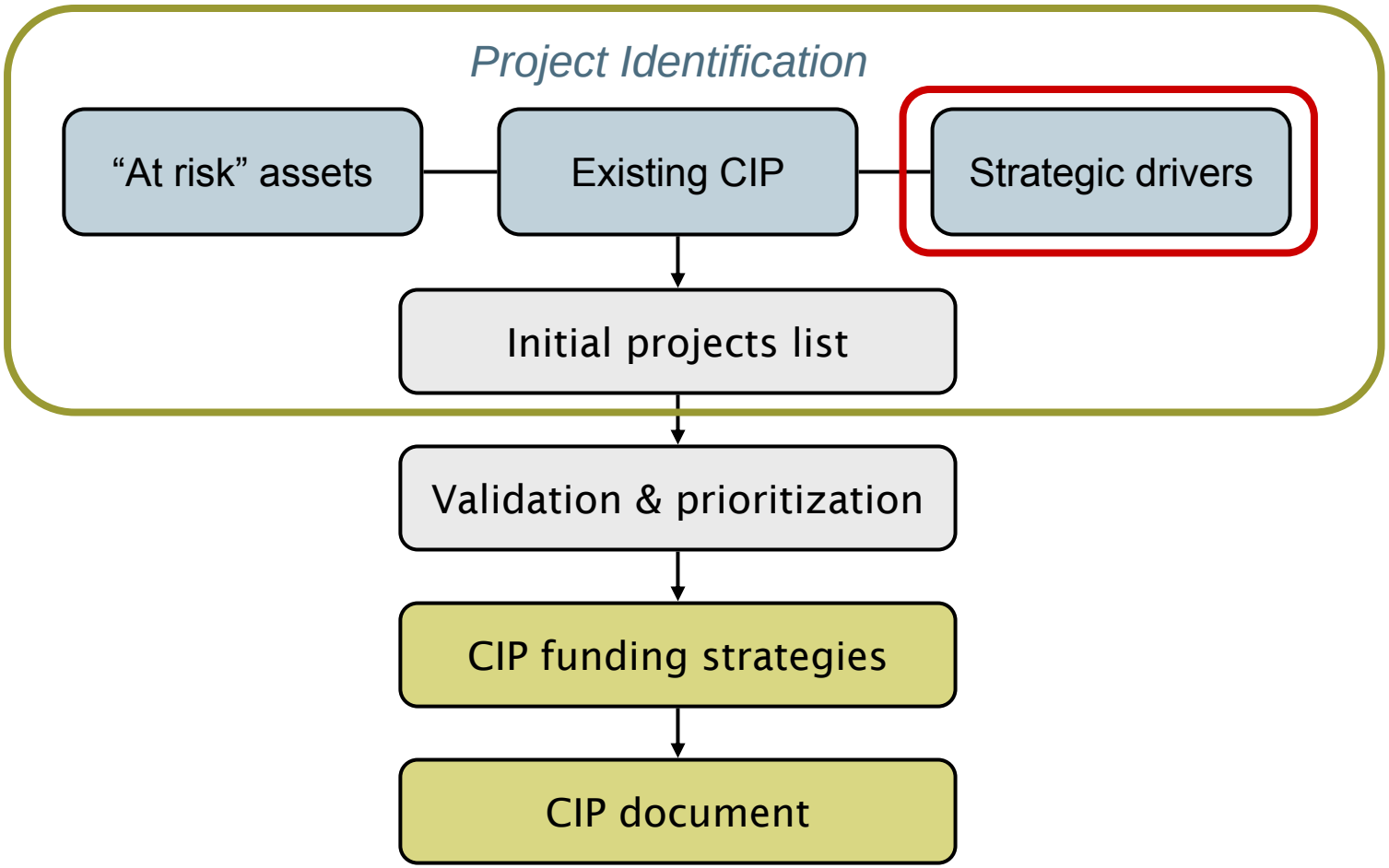


Project Development (optimal Investment)

AMP (whole portfolio)

- Inventory
- Condition
- Failure modes
- Residual life
- Replacement $
- LOS
- ODM

The project development process

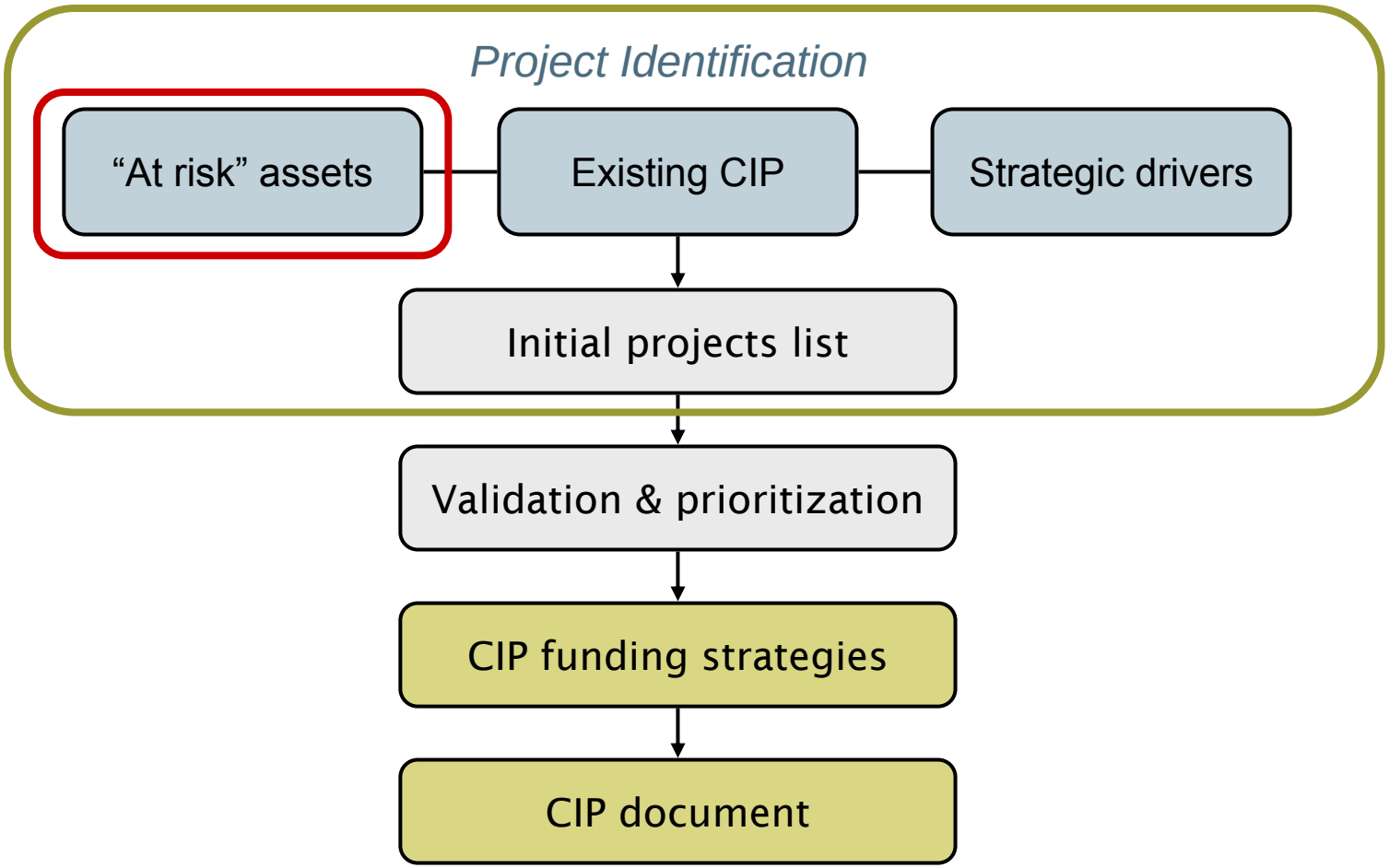


The “primary failure mode” gives insight into “strategic drivers” at work

Failure Mode	*Definition*	*Tactical Aspects*	*Management Strategy*
Capacity	Volume of demand exceeds design capacity	Growth, system expansion	(Re)design
LOS	Functional requirements exceed design capacity	Codes & permits: NPDES, CSOs, OSHA, noise, odor, life safety; service, etc.	(Re)design
Mortality	Consumption of asset reduces performance below acceptable level	Physical deterioration due to age, usage (including operator error), acts of nature	O&M optimization, renewal
Efficiency	Operations costs exceed that of feasible alternatives	Pay-back period	Replace

NPDES is National Pollutant Discharge Elimination System, CSOs are combined sewer overflows, and OSHA is Occupational Safety and Health Administration

The project development process

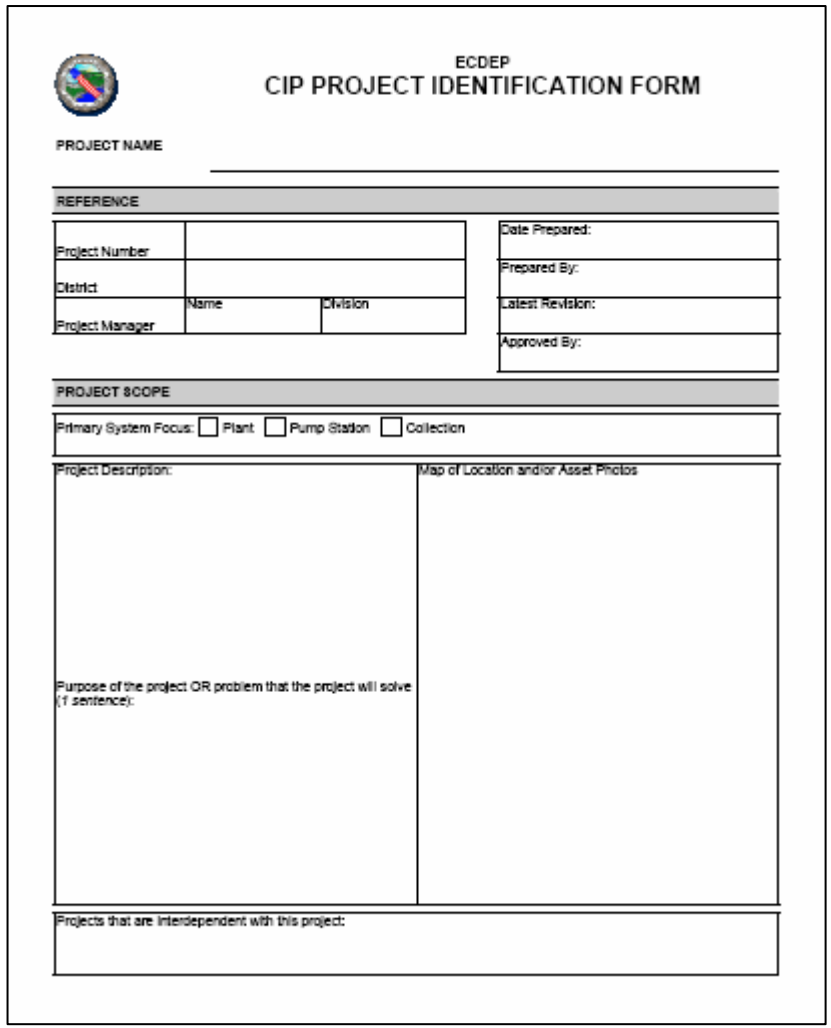


“At risk” assets

- High business risk exposure scores
- Very low remaining useful lives
- Poor condition scores or scores approaching designated minimum acceptable levels
- Poor performance scores
- Poor reliability scores
- No redundancy
- Imminent major failure mode of “capacity” or “level of service”

Each project should have a CIP project identification sheet that identifies…

- Proposed scope
- Location
- Background & context
- Rationalization
- Fiscal requirements
- Design issues
- Permits required
- Comments



ECDEP

CIP PROJECT IDENTIFICATION FORM

PROJECT NAME

REFERENCE

Project Number			Date Prepared:
District			Prepared By:
Project Manager	Name	Division	Latest Revision:
			Approved By:

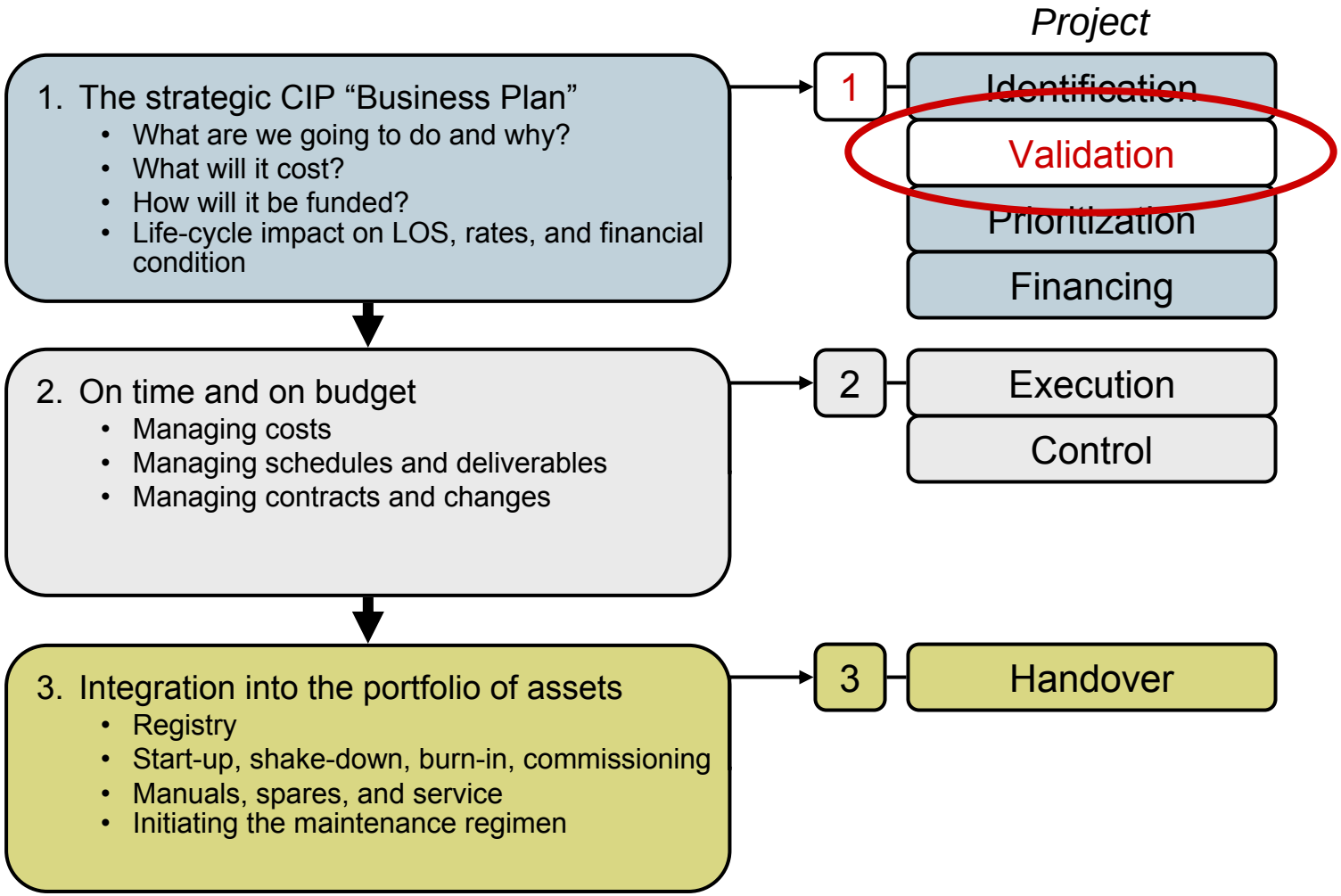
PROJECT SCOPE

Primary System Focus: ☐ Plant ☐ Pump Station ☐ Collection

Project Description: Purpose of the project OR problem that the project will solve (1 sentence):	Map of Location and/or Asset Photos

Projects that are interdependent with this project:

Deriving the CIP investment program – a best practice model



Driving down the cost of CIP

Can we…

- Eliminate projects?
- Defer projects?
  - Change maintenance?
  - Change operations?
- Shift to more appropriate Optimized Renewal Decision Making (ORDM) solution (repair, refurbish, replace)?
- Find a non-asset solution?

CIP validation

How do we know that we have…

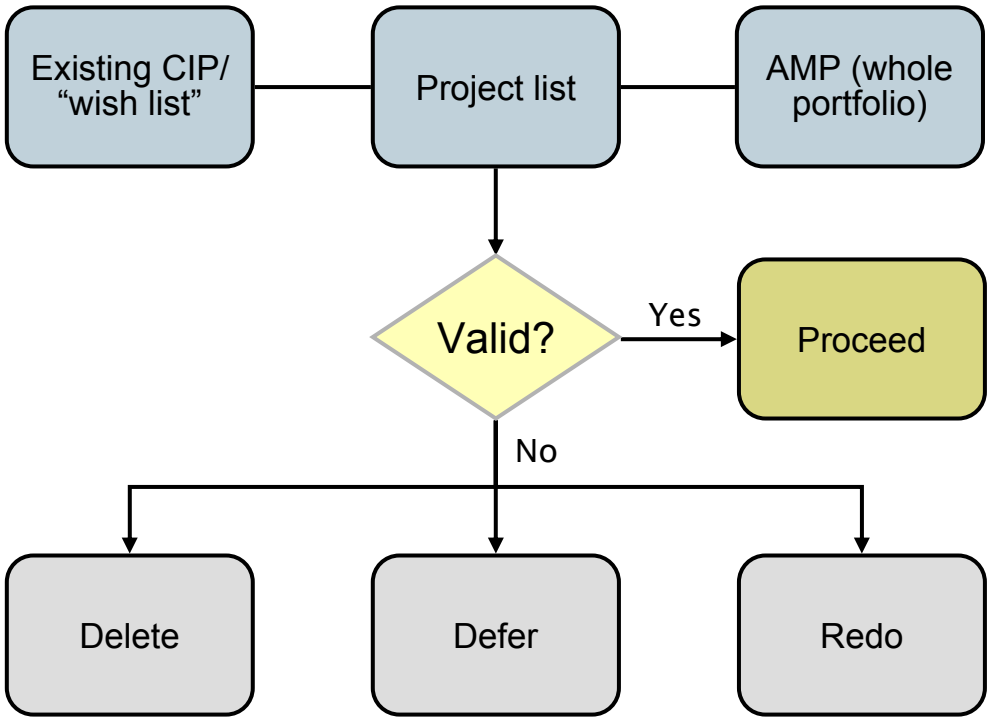
- The right projects?
- At the right time?
- At the right cost?
- For the right reasons?

CIP Validation

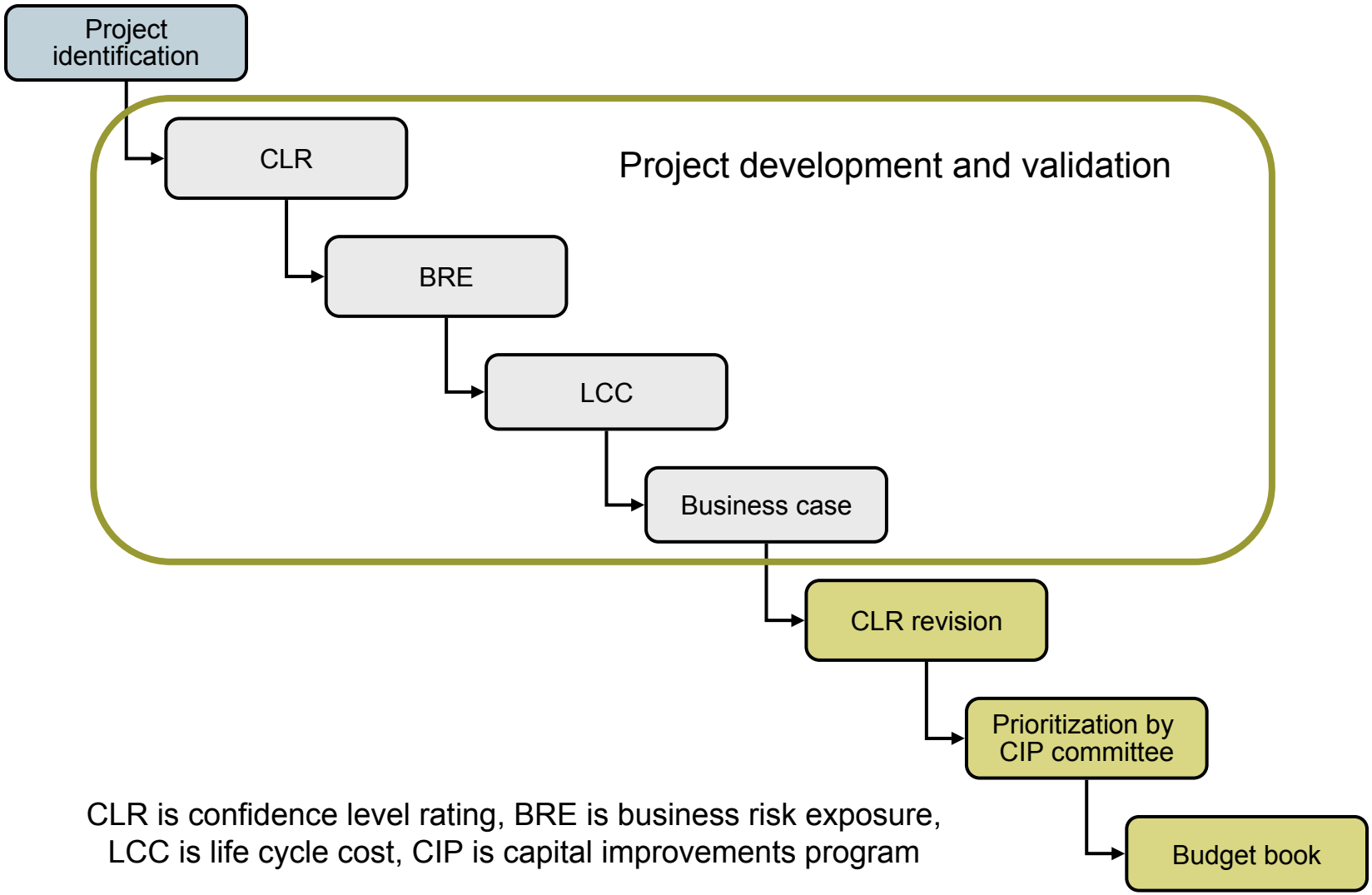
How do we “validate”?

- We produce a rigorous *business case* for all projects that justifies the timing and project solution including
  - Life cycle cost (capital and O&M)
  - “Triple bottom line” risks (financial, social, and environmental)
- We *sufficiently analyze* in a step-by-step approach to ensure that we have reached an *acceptable level of confidence* (confidence level rating—CLR)
- We set the sophistication of analytical process to match the *risks, value of the capital, and life cycle costs* to be invested

Validation as a “decision” filter

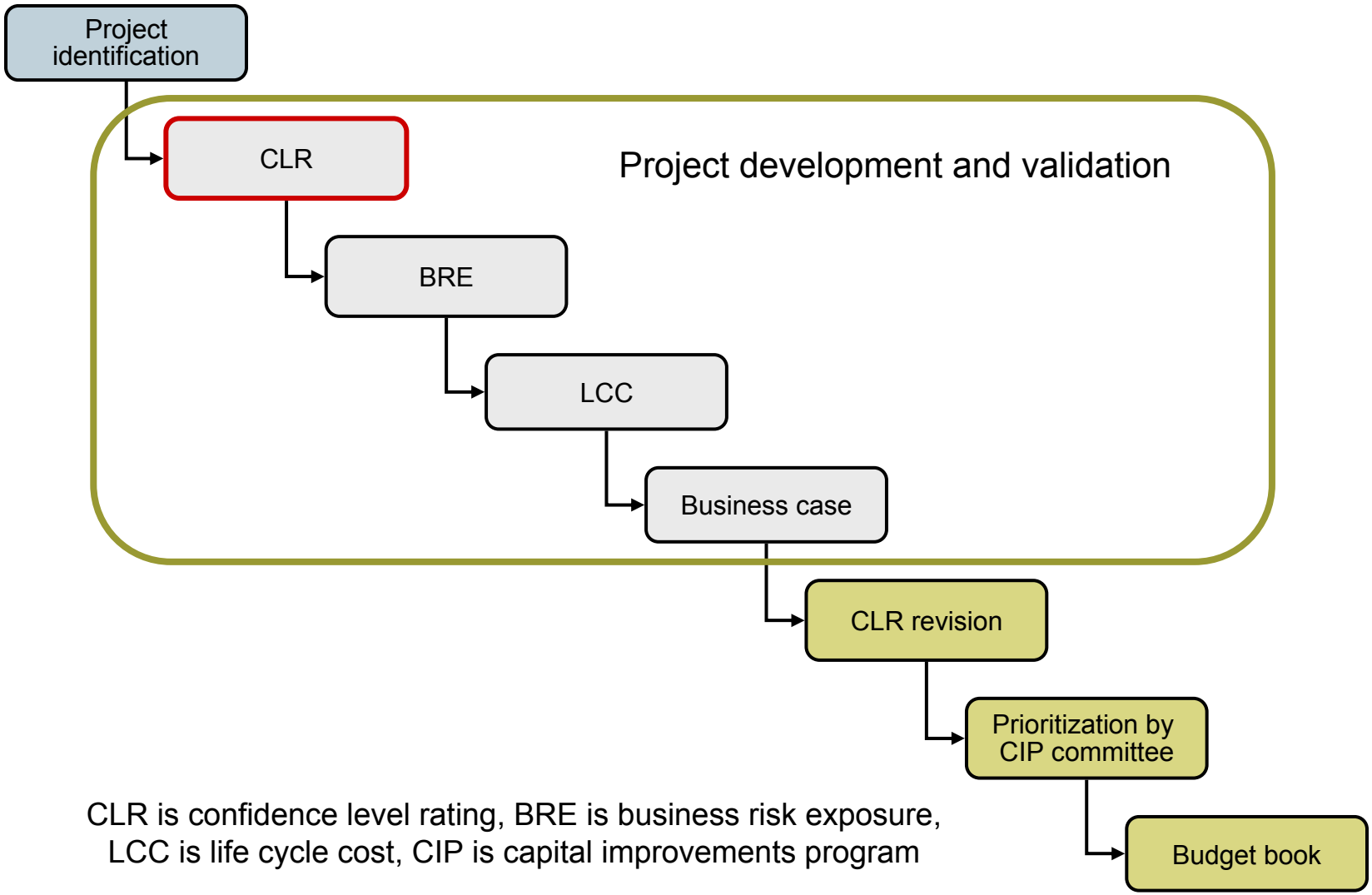


Process steps



CLR is confidence level rating, BRE is business risk exposure, LCC is life cycle cost, CIP is capital improvements program

Process steps



CLR is confidence level rating, BRE is business risk exposure, LCC is life cycle cost, CIP is capital improvements program

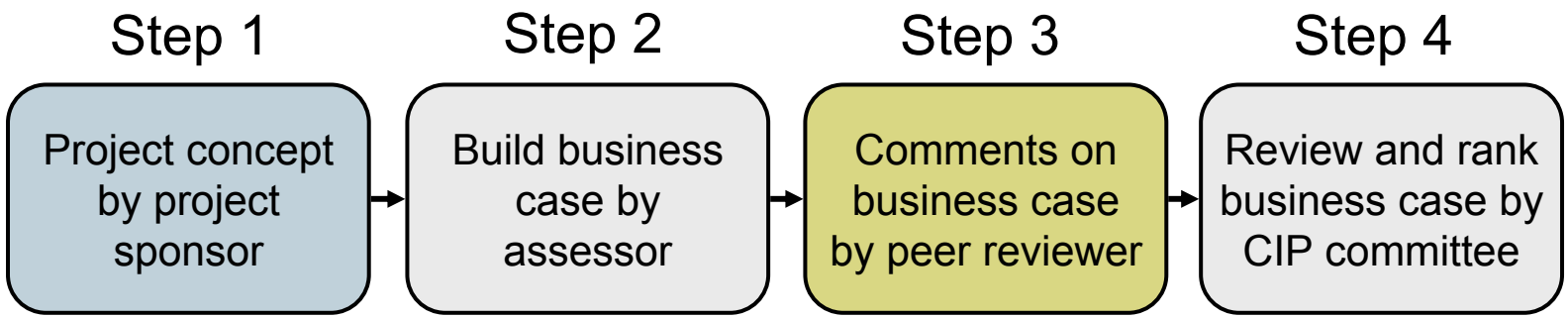
Measuring our confidence in our proposed projects and solutions

How confident are we that we are recommending the right *solution* at the right *time* at the right *cost*?

$$\frac{\text{Best Appropriate Process} + \text{Quality of Date Used}}{2} = \text{Confidence Level Rating (CLR)}$$

$$\frac{70\% + 40\%}{2} = 55\%$$

Confidence level rating process steps



CLR: 13 elements to be considered

1. Existing standard of service?

   What is the purpose of the asset? Why is it there?

2. Knowledge of existing asset or facility (renewal)
   - What condition is the asset in?
   - What is its performance? It's reliability?

3. Current asset utilization (renewal)

   What is the asset actually delivering vs. what do I require the asset to do?

CLR: 13 elements to be considered, cont.

4. Future demands and reliability

   What increase in level of service is expected in the future?

5. Prediction of reliability and failure mode (renewal)

   Of the four failure modes (Capacity, Level of Service, Mortality and Efficiency), which one is most eminent?

6. Timing of reliability / renewal failure

   How likely is this failure to occur?

7. Consequence of reliability and renewal failure

   What is the impact of this failure?

CLR: 13 elements to be considered, cont.

8. Quality of proposed maintenance program

   How good are my estimates for maintenance costs for this project? Do I understand the most appropriate regimen across its life cycle?

9. Appropriateness of operating budgets

   How good are my estimates for operating costs for this project?

10. Appropriateness of renewal solution

    Have we systematically considered all nine treatment options (do nothing, status quo, operate differently, maintain differently, repair, refurbish/rehabilitate, replace, decommission, and non-asset based)?

CLR: 13 elements to be considered, cont.

11. Assessment of capital costs

    How good are my estimates for capital costs?

12. Assessment of benefits (risk reduction)
    - What am I really getting for doing this project and have I adequately quantified it?
    - Will this provide real benefit to stakeholders?
    - Have I done the homework to understand the benefits?

13. Appropriateness of evaluation process

    Have I balanced business risk and all (life cycle) costs and benefits and documented them in a business case?

Confidence Level Assessment & Rating

"Gap" is difference between a "perfect" score of 100 and actual score

LEVEL 2: Overall Confidence Levels LOS Capital Improvement Projects

No.	Quality Element	Project Value Chain: External Regulation (Civil)	Process Effectiveness	Data & Knowledge Quality	Effectiveness Score	Quality Score	Quality Rating	Confidence Level	Rating Gap
Understanding of existing service									
1	Existing Standard of Service	2%	Formal written standard adopted by legislative body	Large technical group - sound, accurate knowledge	100%	60%	80%	2%	0%
2	Knowledge of Existing Asset / Facility	4%	Informal specific knowledge based on informal records applied	Large technical group - sound, accurate knowledge	50%	60%	55%	2%	2%
Demands placed on service									
3	Current Demands for Service	0%	Current demand specifically analyzed and estimated	Full data and costs down to maintenance managed item level	100%	100%	100%	0%	0%
4	Future Demands for Service	5%	Future demand specifically analyzed and projected	Full data and costs down to maintenance managed item level	100%	100%	100%	5%	0%
Service failures									
5	Predicted Modes of Service Failure	0%	Major (strategic) failure modes analyzed	Large technical group - sound, accurate knowledge	75%	60%	68%	0%	0%
6	Probability / Timing of Failure	0%	Formal analysis at facility/major process or higher level	Moderate data from asset management information system	75%	85%	80%	0%	0%
7	Consequence of Failure	15%	Specific but informal consideration given	Medium technical group - moderate knowledge	50%	50%	50%	8%	8%
Analysis approach									
8	Quality of Proposed Maintenance Programs	7%	Formal analysis at facility/major process or higher level	Large technical group - sound, accurate knowledge	75%	60%	68%	5%	2%
9	Appropriateness of Recurrent Budgets	10%	Formal analysis at facility/major process or higher level	Large technical group - sound, accurate knowledge	75%	60%	68%	7%	3%
10	Appropriateness of Renewal Solutions Considered	10%	Formal analysis at facility/major process or higher level	Key basic data from asset management information system	75%	75%	75%	8%	3%
11	Assessment of Capital Cost Estimates	12%	Formal analysis at asset or lower level	Large technical group - sound, accurate knowledge	100%	60%	80%	10%	2%
12	Assessment of Benefits (Risk Reduction)	15%	Formal analysis at facility/major process or higher level	Key basic data from asset management information system	75%	75%	75%	11%	4%
13	Appropriateness of Economic Evaluation Process	20%	Specific but informal consideration given	Medium technical group - moderate knowledge	50%	50%	50%	10%	10%
	TOTALS	100%						66%	34%

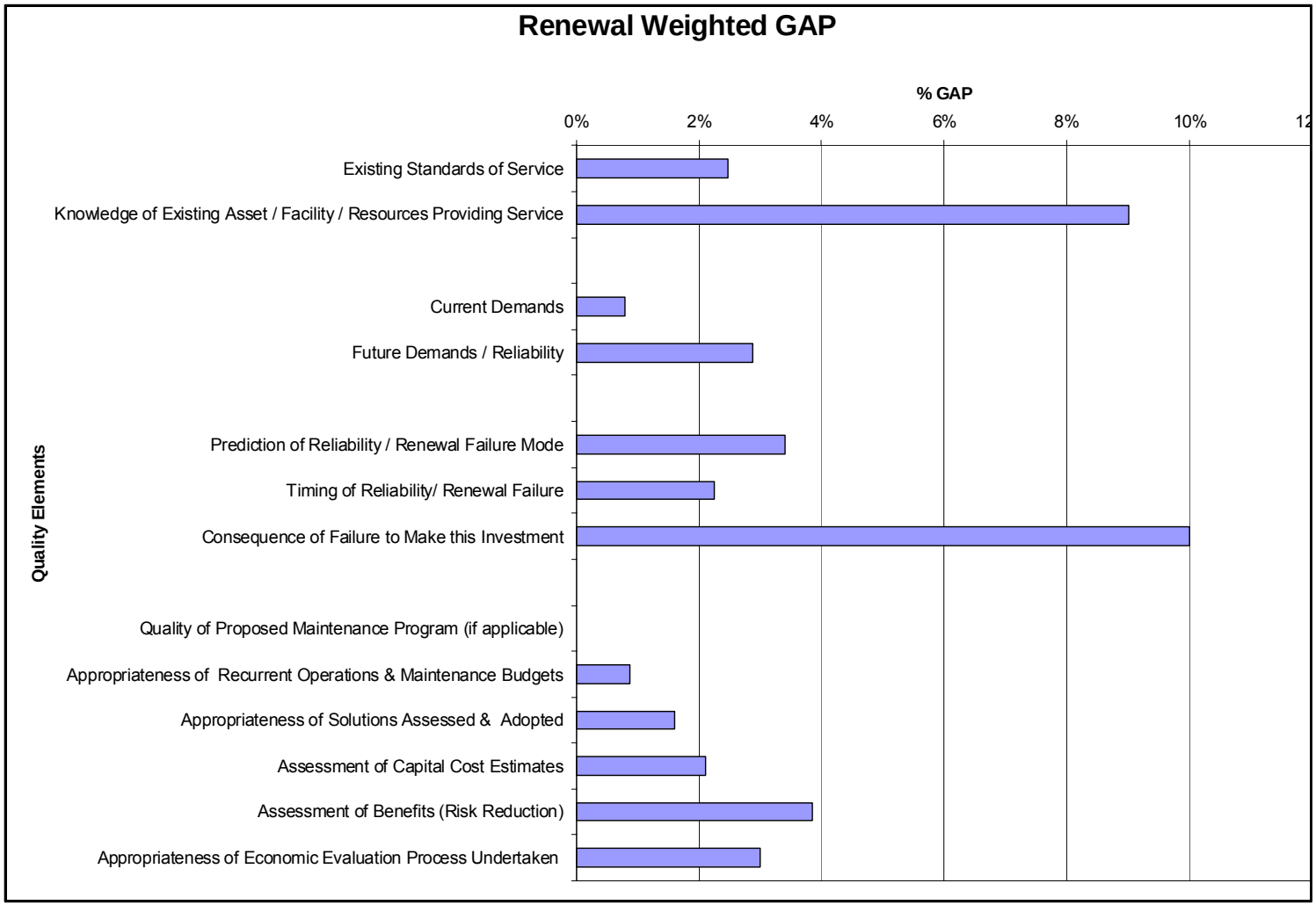
Scoring “protocol”

Table 3 Scoring the Processes & Practices

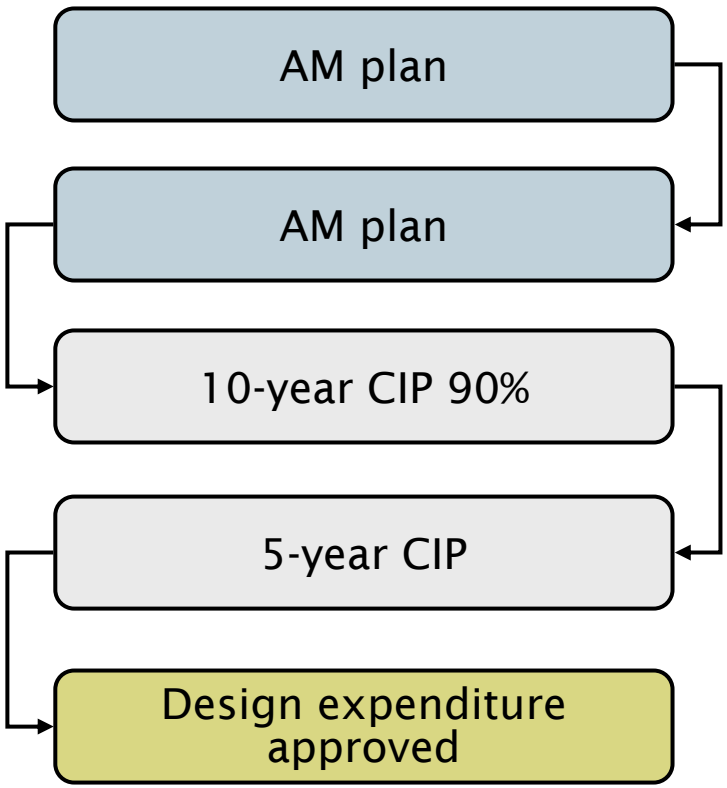
Assessment Score	Processes & Practice Followed
0%	No process applied to quality element
25%	Some consideration given to process
50%	
70%	
80%	
90%	
100%	

Assessment Score	Description of Data Used
0%	No data available
25%	Some minor data available
40%	Small Delphi Group - poor knowledge
50%	Medium Delphi Group - reasonable knowledge
60%	Large Delphi Group - sound accurate knowledge
75%*	Key base principle data from AMIS
85%*	Secondary data from AMIS
100%*	Full tertiary data & costs down to MMI

Weighted gap improvements

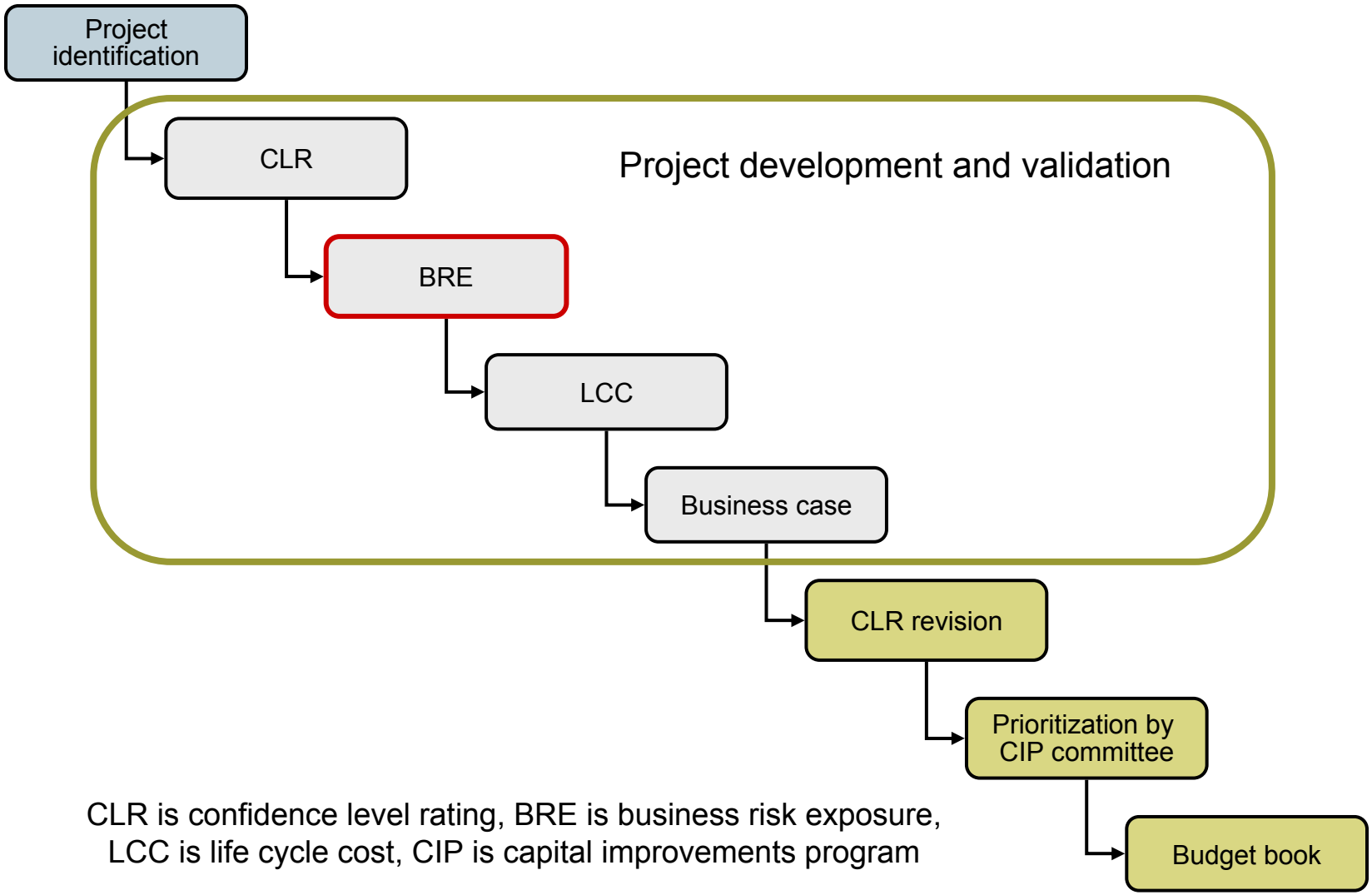


CIP “hurdle” stages



Source	Period (years)	Minimum CLR rating
AM plan	16-25	60%
AM plan	11-15	70%
10-year CIP 90%	6-10	80%
5-year CIP	2-5	85%
Design expenditure approved	1	90%

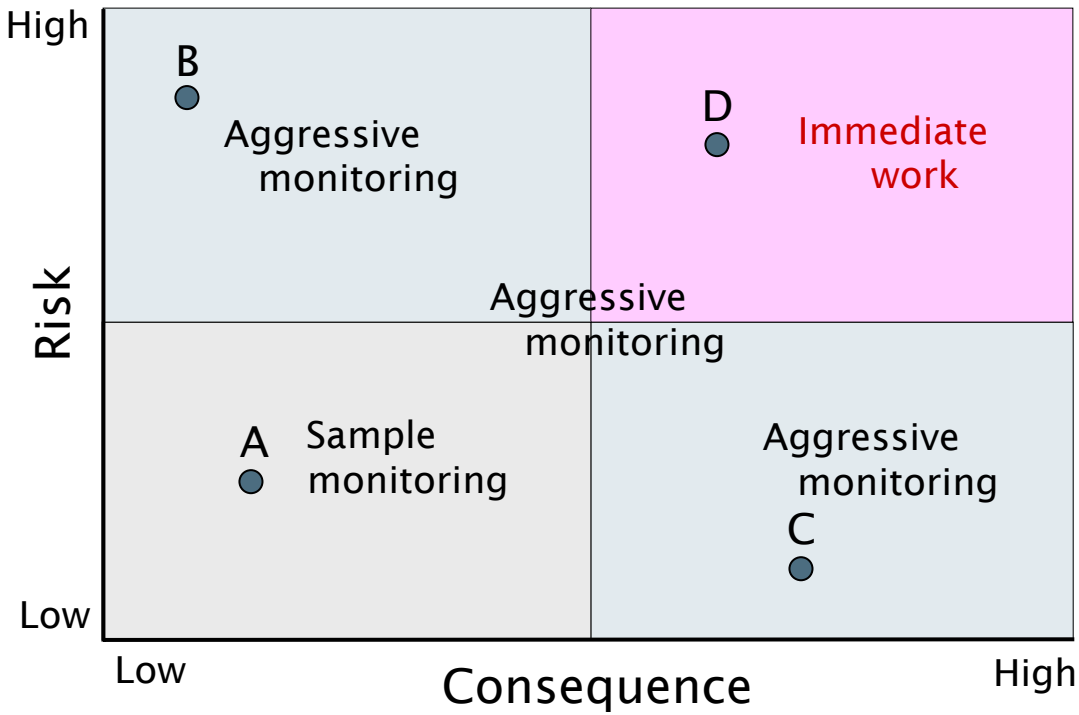
Process steps



CLR is confidence level rating, BRE is business risk exposure, LCC is life cycle cost, CIP is capital improvements program

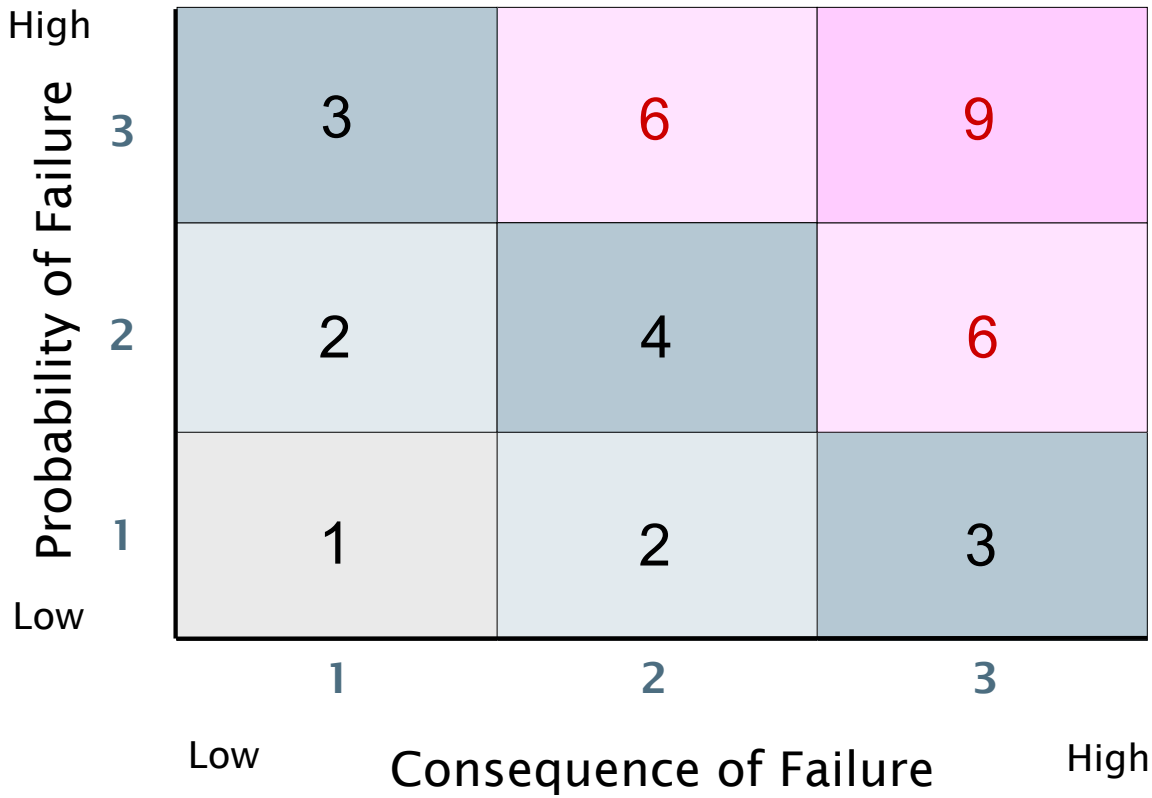
Recall: Business risk exposure drives work program

Work program response

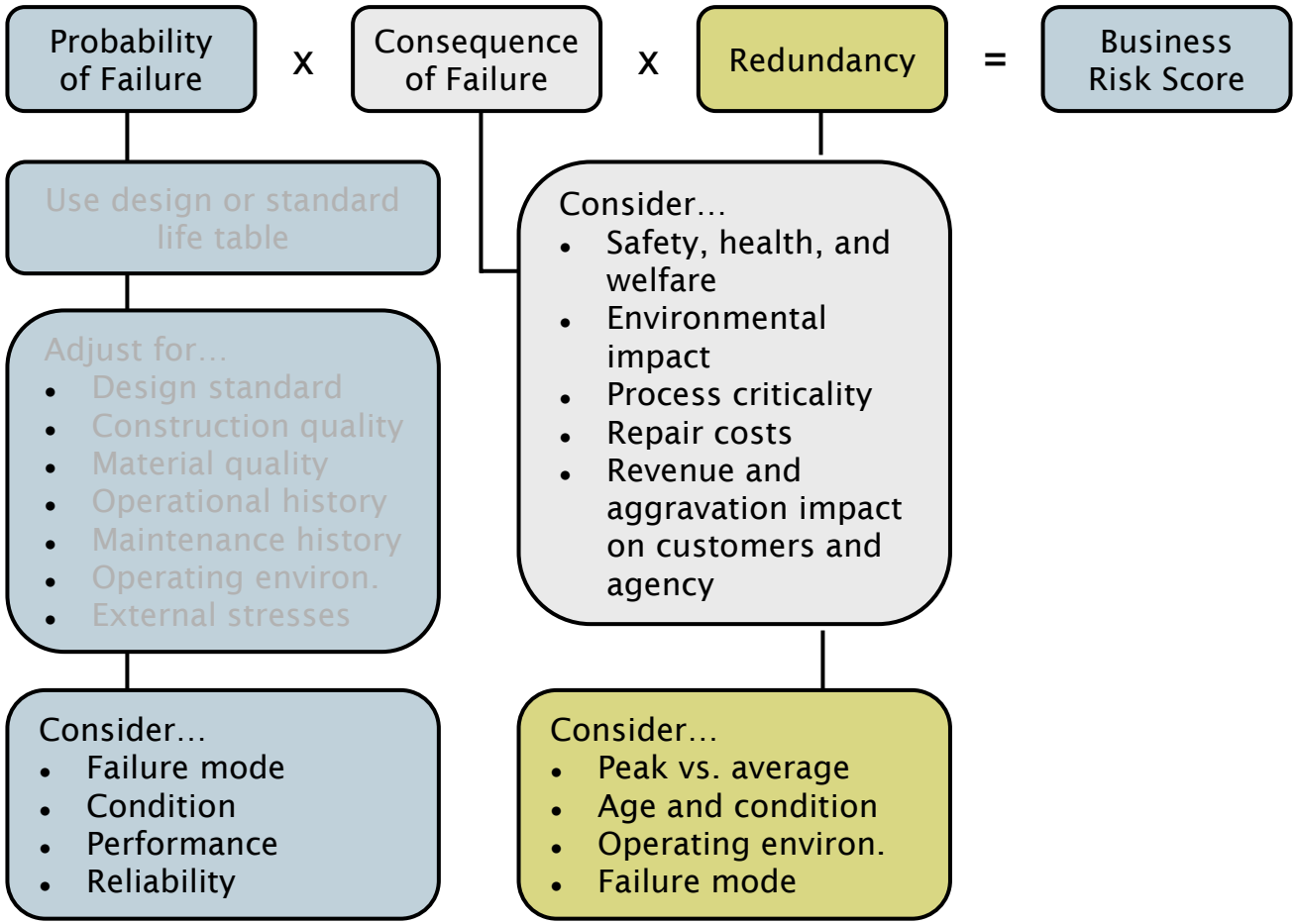


BRE 1—simple approach

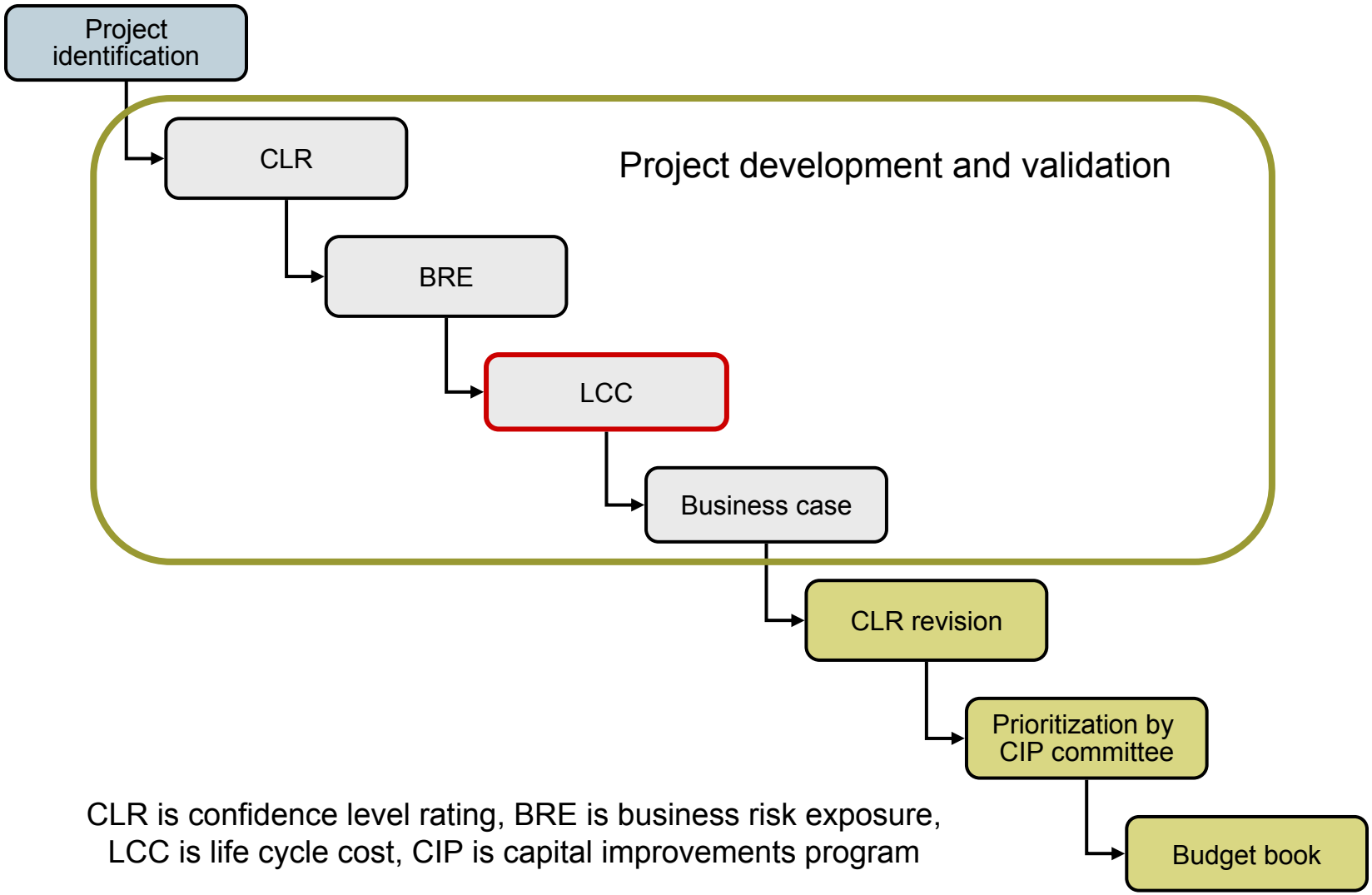
Business risk exposure (BRE) increases (higher numbers) as probability of failure (PoF) and consequence of failure (CoF) increase



Calculating business risk exposure (BRE) – project level



Process steps



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Recall: Defining life cycle cost

Life cycle cost = *original* cost
– *salvage* value
+ *operating* costs
+ *maintenance* costs
+ *renewal* costs
+ *decommissioning* costs

Life cycle cost – for each feasible option

Microsoft Excel - ODM Example.xls

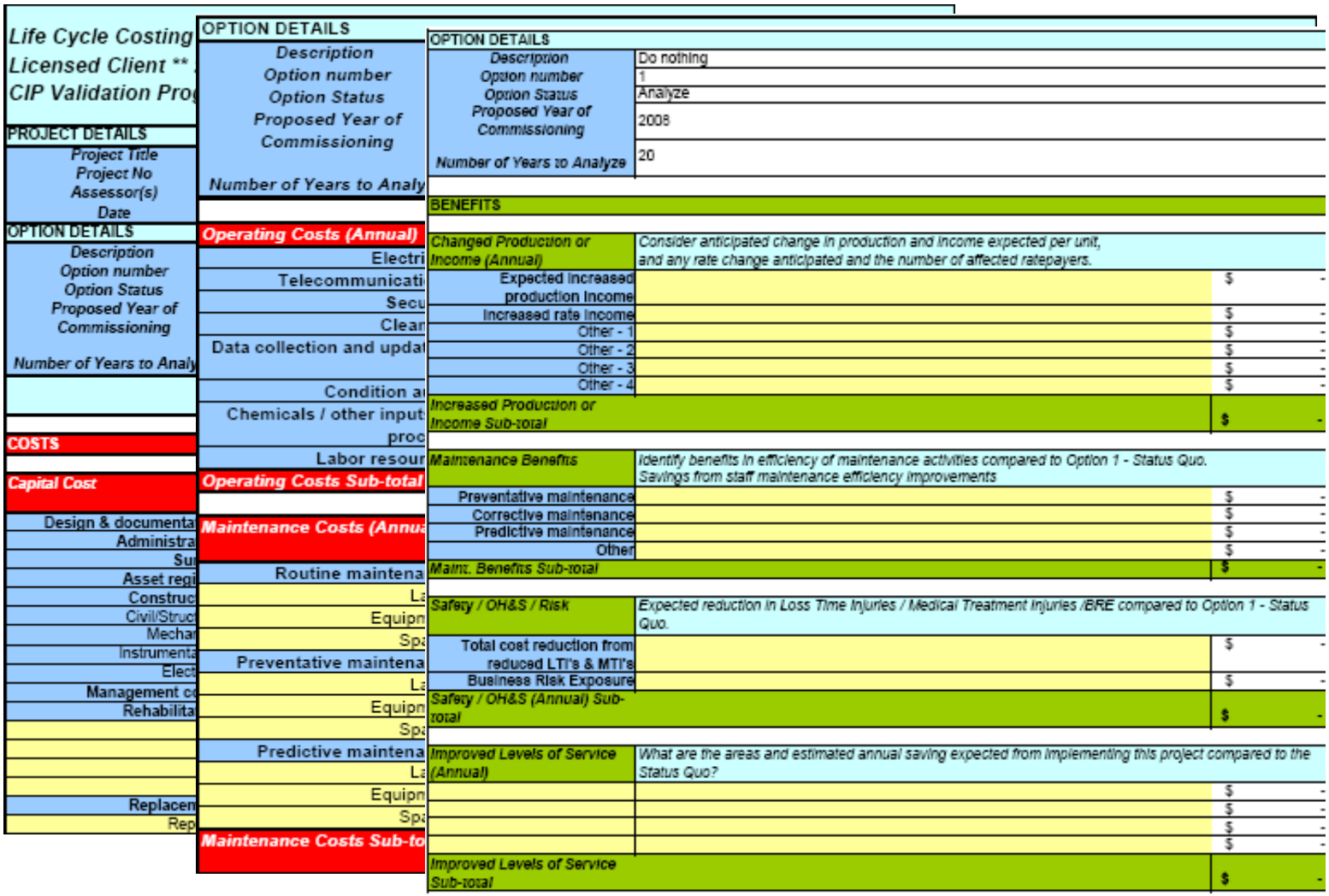
File Edit View Insert Format Tools Data Window Help Adobe PDF

Arial 10 B I U

F25 =

	A	B	C	D	E	F	G	H	I	J	K	L
1	Discount Rate	1.0%	Avg Annual $									
2	**Repair/Maintenance**	**Total**		1	2	3	4	5				
3	Capital	$ 4,500		$ 4,500	$ -	$ -	$ -					
4	Operations	$ 2,033.91		$ 350.00	$ 402.50	$ 414.58	$ 427.01	$ 439.82				
5	Maintenance	$ 1,803.29		$ 350.00	$ 355.25	$ 360.58	$ 365.99	$ 371.48				
6	Total Costs	$ 8,337.20	$ 1,667	$ 5,200.00	$ 757.75	$ 775.15	$ 793.00	$ 811.30				
7	PV Total Costs	$ 8,259.45	$ 1,652	$5,200.00	$750.25	$759.88	$769.68	$779.64				
8												
9	**Refurbish**			1	2	3	4	5	6	7	8	
10	Capital	$35,500.00		$ 1,775.00	$ 1,775.00	$ 1,775.00	$ 1,775.00	$ 1,775.00	$1,775.00	$1,775.00	$1,775.00	$1,775
11	Operations	$ 7,515.19		$ 325.00	$ 329.88	$ 334.82	$ 339.85	$ 344.94	$ 350.12	$ 355.37	$ 360.70	$ 366
12	Maintenance	$ 6,887.73		$ 275.00	$ 279.13	$ 283.31	$ 287.56	$ 291.87	$ 296.25	$ 300.70	$ 305.21	$ 309
13	Total Costs	$49,902.92	$ 2,495	$ 2,375.00	$ 2,384.00	$ 2,393.14	$ 2,402.41	$ 2,411.82	$2,421.37	$2,431.07	$2,440.91	$2,450
14	PV Total Costs	$45,382.14	$ 2,269	$2,375.00	$2,360.40	$2,345.98	$2,331.75	$2,317.71	$2,303.85	$2,290.17	$2,276.68	$2,263
15												
16	**Replace**			1	2	3	4	5	6	7	8	
17	Capital	$61,000.00		$ 1,525.00	$ 1,525.00	$ 1,525.00	$ 1,525.00	$ 1,525.00	$1,525.00	$1,525.00	$1,525.00	$1,525
18	Operations	$10,853.58		$ 200.00	$ 203.00	$ 206.05	$ 209.14	$ 212.27	$ 215.46	$ 218.69	$ 221.97	$ 225
19	Maintenance	$12,243.67		$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 200.00	$ 225.00	$ 228.38	$ 231.80	$ 235
20	Total Costs	$84,097.25	$ 2,102	$ 1,925.00	$ 1,928.00	$ 1,931.05	$ 1,934.14	$ 1,937.27	$1,965.46	$1,972.06	$1,978.77	$1,985
21	PV Total Costs	$69,240.55	$ 1,731	$1,925.00	$1,908.91	$1,893.00	$1,877.25	$1,861.68	$1,870.06	$1,857.77	$1,845.63	$1,833
22												

Life cycle cost – for each feasible option



Life Cycle Costing
Licensed Client **
CIP Validation Pro

PROJECT DETAILS
Project Title
Project No
Assessor(s)
Date

OPTION DETAILS
Description
Option number
Option Status
Proposed Year of Commissioning
Number of Years to Analy

COSTS
Capital Cost
Design & documenta
Administra
Su
Asset regi
Construc
Civil/Struc
Mecha
Instrumenta
Elect
Management co
Rehabilita
Replacen
Rep

OPTION DETAILS
Description
Option number
Option Status
Proposed Year of Commissioning
Number of Years to Analy

Operating Costs (Annual)
Electri
Telecommunicati
Secu
Clean
Data collection and updat
Condition a
Chemicals / other input proc
Labor resour
Operating Costs Sub-total

Maintenance Costs (Annu
Routine maintena
La
Equipn
Spa
Preventative maintena
La
Equipn
Spa
Predictive maintena
La
Equipn
Spa
Maintenance Costs Sub-to

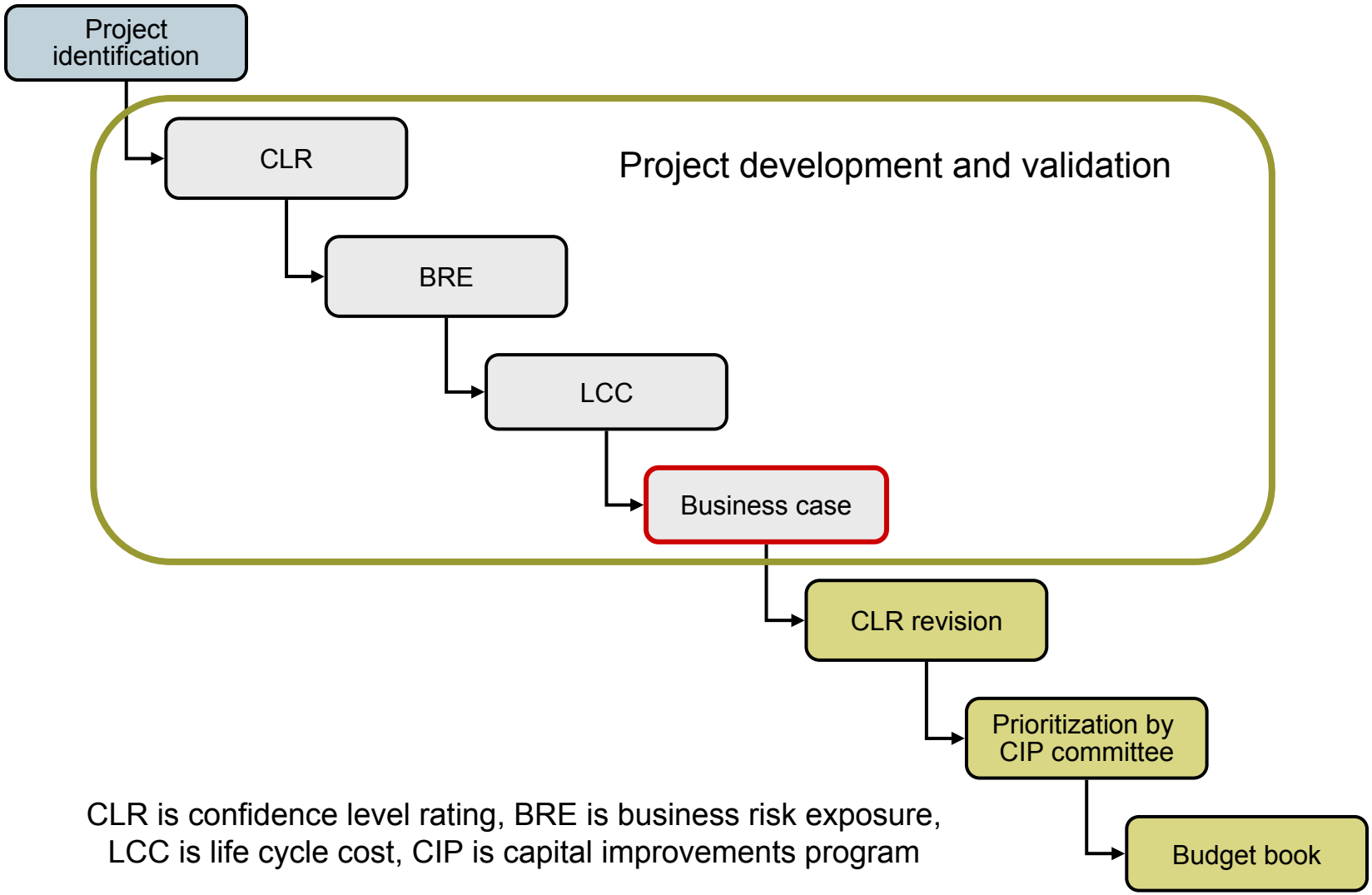
OPTION DETAILS

Description	Do nothing
Option number	1
Option Status	Analyze
Proposed Year of Commissioning	2008
Number of Years to Analyze	20

BENEFITS

Changed Production or Income (Annual)	Consider anticipated change in production and income expected per unit, and any rate change anticipated and the number of affected ratepayers.	
Expected increased production income		$ -
Increased rate income		$ -
Other - 1		$ -
Other - 2		$ -
Other - 3		$ -
Other - 4		$ -
Increased Production or Income Sub-total		$ -
Maintenance Benefits	Identify benefits in efficiency of maintenance activities compared to Option 1 - Status Quo. Savings from staff maintenance efficiency improvements	
Preventative maintenance		$ -
Corrective maintenance		$ -
Predictive maintenance		$ -
Other		$ -
Maint. Benefits Sub-total		$ -
Safety / OH&S / Risk	Expected reduction in Loss Time Injuries / Medical Treatment Injuries /IBRE compared to Option 1 - Status Quo.	
Total cost reduction from reduced LTI's & MTI's		$ -
Business Risk Exposure		$ -
Safety / OH&S (Annual) Sub-total		$ -
Improved Levels of Service (Annual)	What are the areas and estimated annual saving expected from implementing this project compared to the Status Quo?	
		$ -
		$ -
		$ -
		$ -
Improved Levels of Service Sub-total		$ -

Process steps



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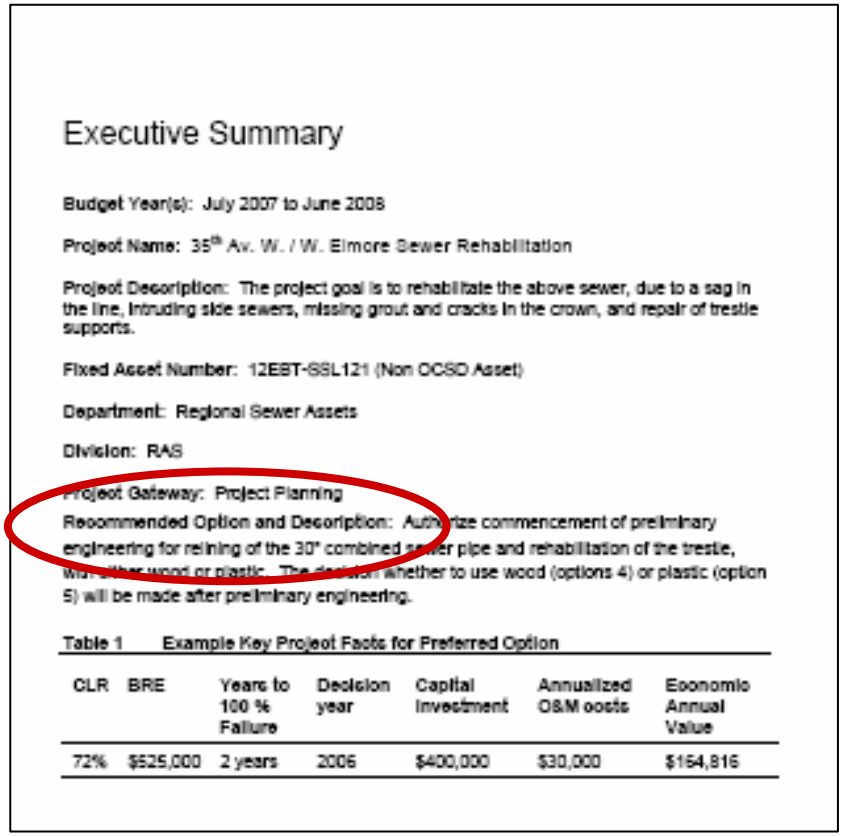
Elements of a “business case”

- Executive Summary
- Part 1, Demand and Supply
  - Objectives
  - Project background
  - Drivers & failure modes
- Part 2, Options Analysis
  - Feasible options defined
  - For each option:
    - Business risk exposure
    - Life cycle costing
    - Confidence level rating (CLR)
  - Summary tables
- Part 3, Recommendation

  Recommended option and description



Executive Summary

Budget Year(s): July 2007 to June 2008

Project Name: 35th Av. W. / W. Elmore Sewer Rehabilitation

Project Description: The project goal is to rehabilitate the above sewer, due to a sag in the line, intruding side sewers, missing grout and cracks in the crown, and repair of trestle supports.

Fixed Asset Number: 12EBT-SSL121 (Non OCSD Asset)

Department: Regional Sewer Assets

Division: RAS

Project Gateway: Project Planning

Recommended Option and Description: Authorize commencement of preliminary engineering for relining of the 30" combined sewer pipe and rehabilitation of the trestle, with either wood or plastic. The decision whether to use wood (options 4) or plastic (option 5) will be made after preliminary engineering.

Table 1 Example Key Project Facts for Preferred Option

CLR	BRE	Years to 100 % Failure	Decision year	Capital Investment	Annualized O&M costs	Economic Annual Value
72%	$525,000	2 years	2006	$400,000	$30,000	$164,816

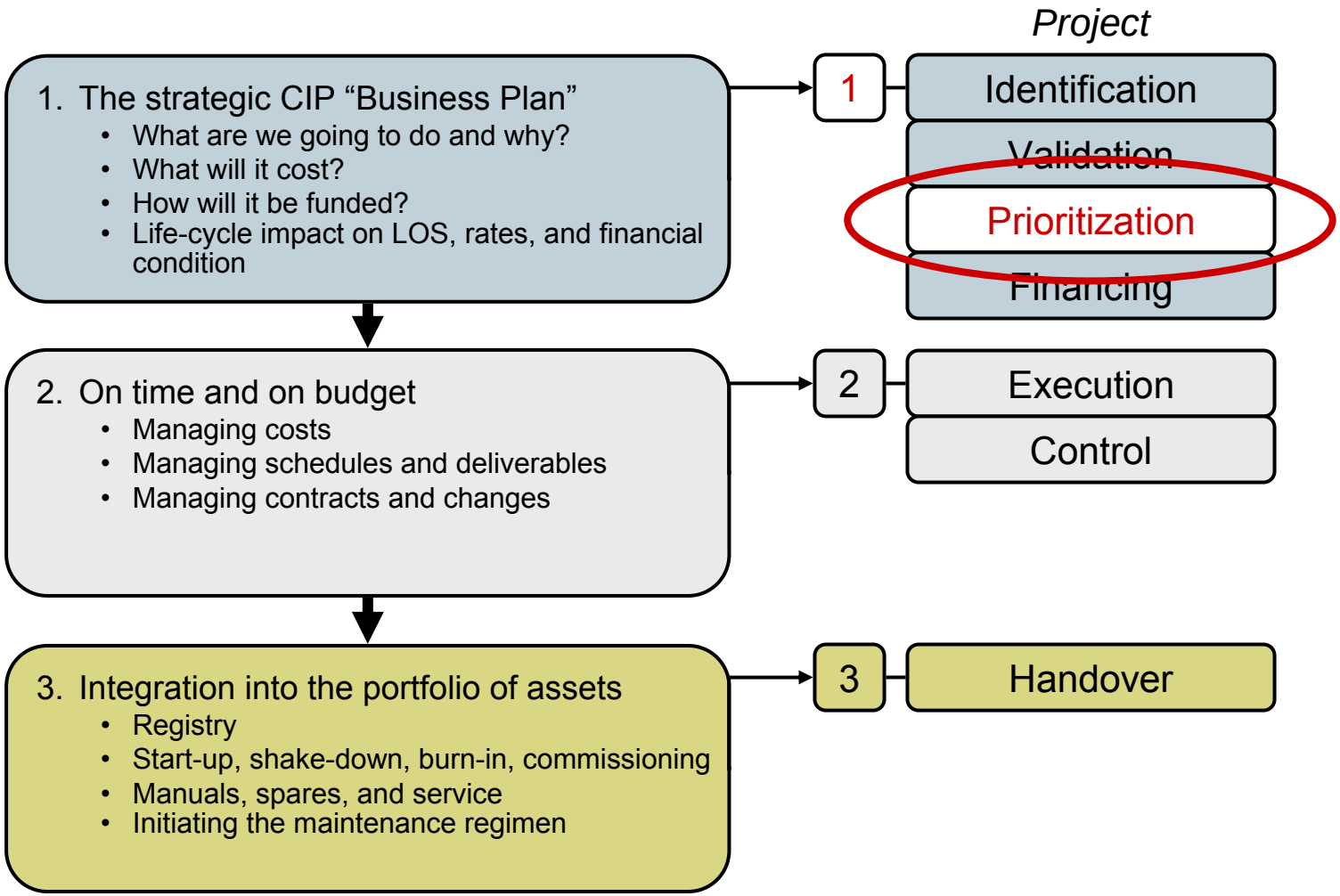
Options analysis - summarized

Option	Business Risk	Capital ($)	Annual Operations	Annual Maintenance	PV of Benefits	NPV	Adjusted Annualized PV	Benefit Cost	Pay Back Period	Total PV/ CLR
Status Quo										
Do Nothing / Run to Fail										
Operate Differently										
Maintain differently										
Repair										
Refurbish / Rehabilitation										
Replace										
Decommission										
Non Asset Solutions										
(Other options)										

Moving forward: Project validation decision matrix

	High BRE (>1M)	*Medium BRE*	*Low BRE (<50K)*
High CLR (>84)	Proceed with project, no changes	Consider proceeding with project if financial criteria are met and funding is available	Consider • Deferral or delay • Project breakup • Cancellation • Increase CLR
Medium CLR (56-84)	Consider • Proceed with project • Deferral or delay • Increase CLR	Consider • Deferral or delay • Breakup project and proceed with parts • Increase CLR	Consider • Deferral or delay • Project breakup • Cancellation • Increase CLR
Low CLR (<56)	Consider • Deferral or delay • Project breakup • Proceed with project using design consultant • Increase CLR	Consider • Deferral or delay • Project breakup • Increase CLR	Consider • Mothball • Deferral or delay • Cancellation • Increase CLR

Deriving the CIP investment program – a best practice model



“Prioritization” rank-orders validated projects

A. Public Health/Safety, Mandated Program, BOC Irrevocable Commitment, Phase Completion	
Points	**Criteria**
20	• Urgent to meet *emergency situations* to remedy or prevent a major health / safety hazard.
19	• Essential to remedy or prevent a major health / safety hazard; • Essential to comply with legally mandated programs and avoid penalty; • Essential to comply with irrevocable commitment by the BOC.
15	• Essential to complete a project phase, otherwise the system will not be operatio
6	• Very positive economic impact; • Ongoing support by BOC for *county grants match and outside agency grants*; • Project identified as highest priority by BOC or County Manager; • Potential hazard – deferral of project would increase significant level of hazard.
3	• Potential hazard – deferral of project would *not* increase significant level of haz
0	• Project does not apply to the aforementioned criteria.

B. Service Delivery, Fiscal Impact, Leverage	
Points	**Criteria**
7	• The project creates revenues or identifies savings *in excess of the project cost* and is justified by a cost benefit analysis; • Implementation plans of the project are required prior to capital allocation and cost savings reduce the base operating budget.
6	• Project significantly improves service delivery which will substantially reduce *subsequent operating or capital costs*; • County funds are reimbursed by the federal or state government at a rate of 50% or greater.
5	• Project significantly improves service delivery and will be utilized by multiple departments with *little or no impact* on future operating or capital costs (less than $20,000 per year); • Essential operating capital to meet service growth and/or mandated programs.
4	• Project significantly improves service delivery with *little or no impact* on future operating or capital costs (less than $10,000 per year); • County funds are reimbursed by the federal or state government at a rate less than 50%.
3	• Project improves service delivery with *no impact* on future operating or capital costs (less than $10,000 per year) • Essential operating capital to meet service growth and / or mandated programs
2	• Project significantly improves service delivery with *moderate impact* on future operating or capital costs ($10,000 – $50,000 per year)
1	• Project significantly improves service delivery with *high impact* on future operating or capital costs (more than $50,000 per year)
0	• Project does not significantly improve service delivery; • Project balance available for annual program; • Project requires further study before consideration.

Example: Possible prioritization factors & weights

Factor	Weight
Public Health/Safety	15
Federal or State Mandated Program	15
Local Irrevocable Commitment	15
Business Risk Exposure	10
Service Delivery Impact	10
Fiscal Impact	10
Conformance with Plan / Policies; Phase Completion/	8
Efficiency Improvement	7
Leverage	6
Project Interdependence	4
Total Maximum Score	**100**

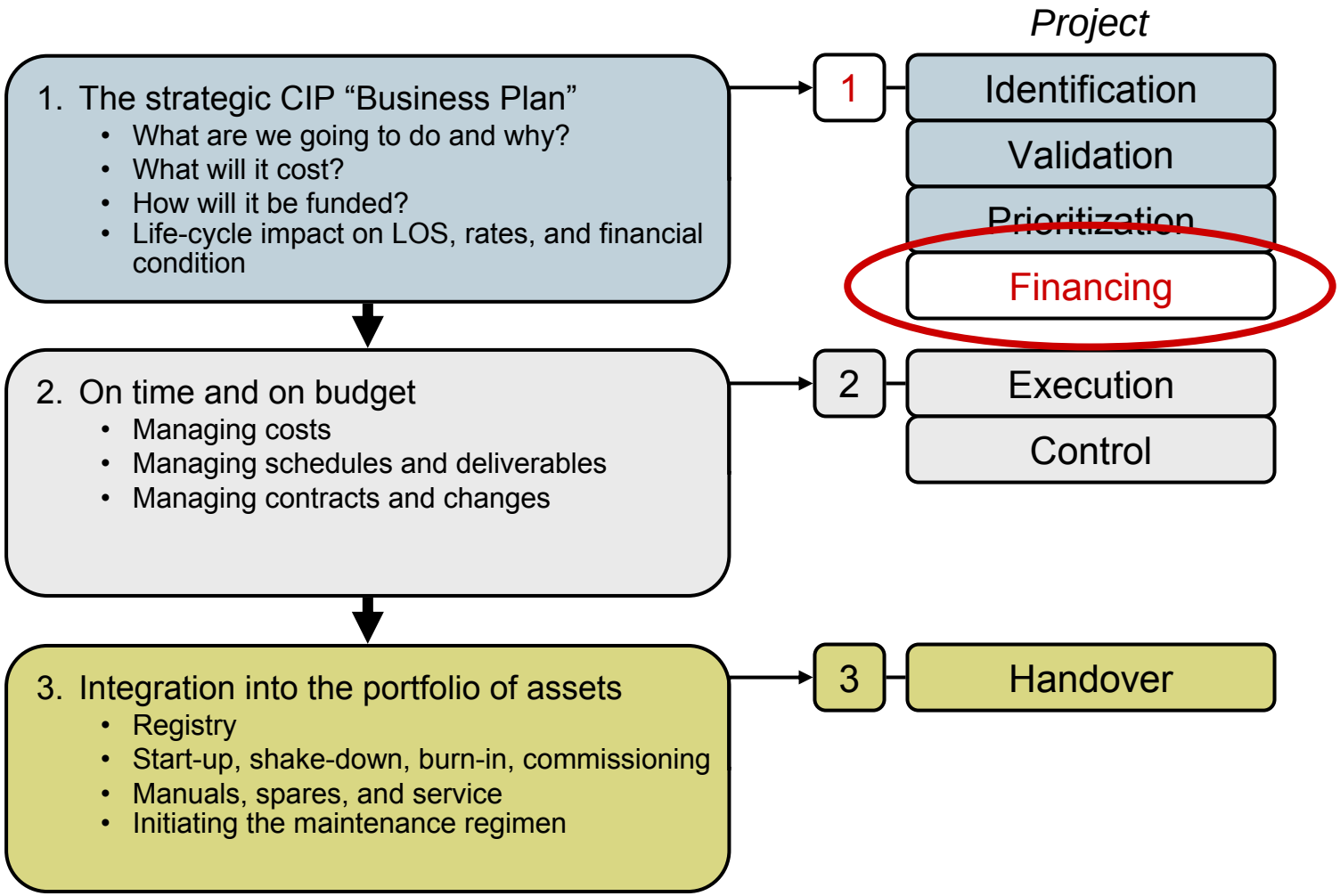
Alternative to prioritization factor weighting

"Risk"

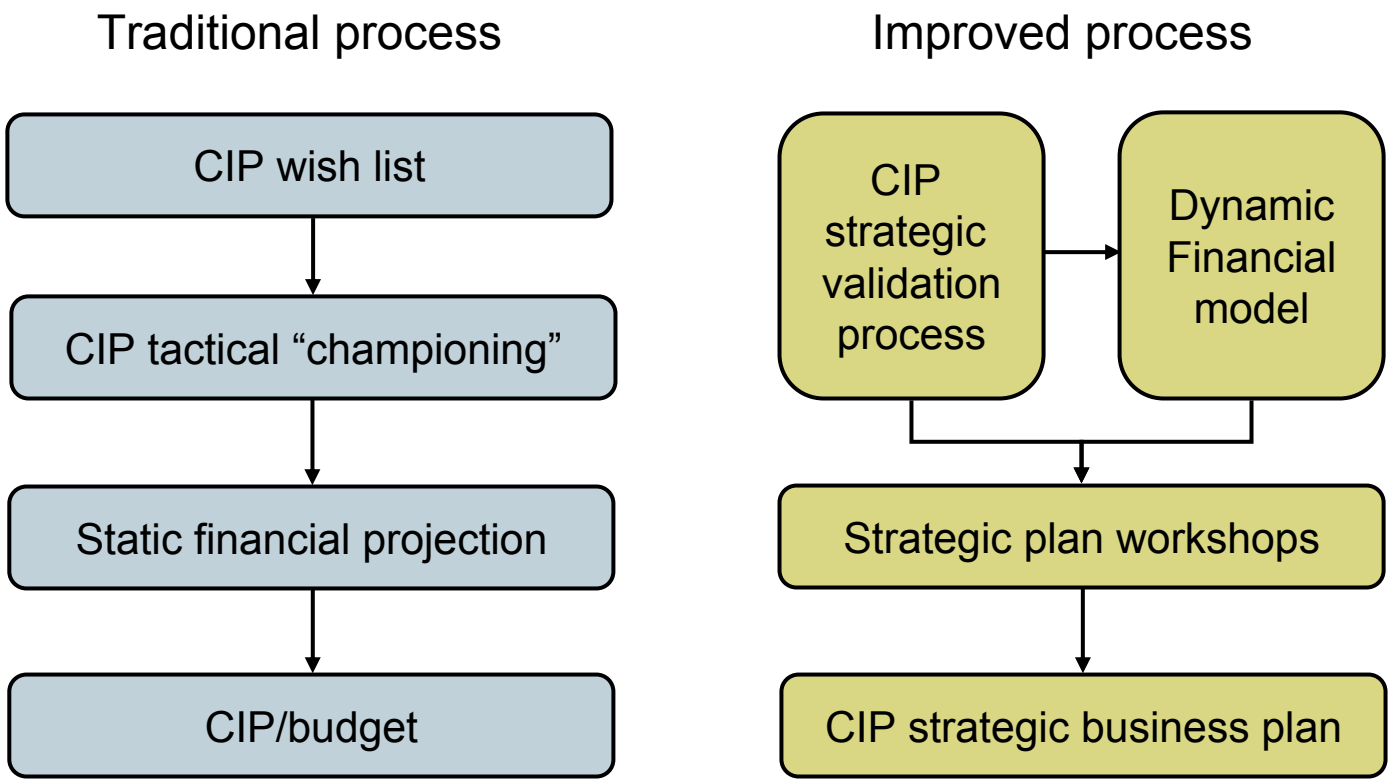
No	Project description	Cost $M	B/C ratio	PBP yrs	CLR	BRE
256	South trunk renewal	4.2	2.42	2.5	**83**	**610**
102	Expand plant automation	6.5	2.35	3.5	**63**	**411**
16	Renew digester heaters	2.8	2.10	4.0	**74**	**219**
205	New CMMS	8.5	1.95	5.0	**69**	**712**
167	Office accommodation	4.7	1.35	6.2	**72**	**813**
150	Siphon renewals	2.6	1.30	7.2	**73**	**471**

Assume agency CIP limit of $25M

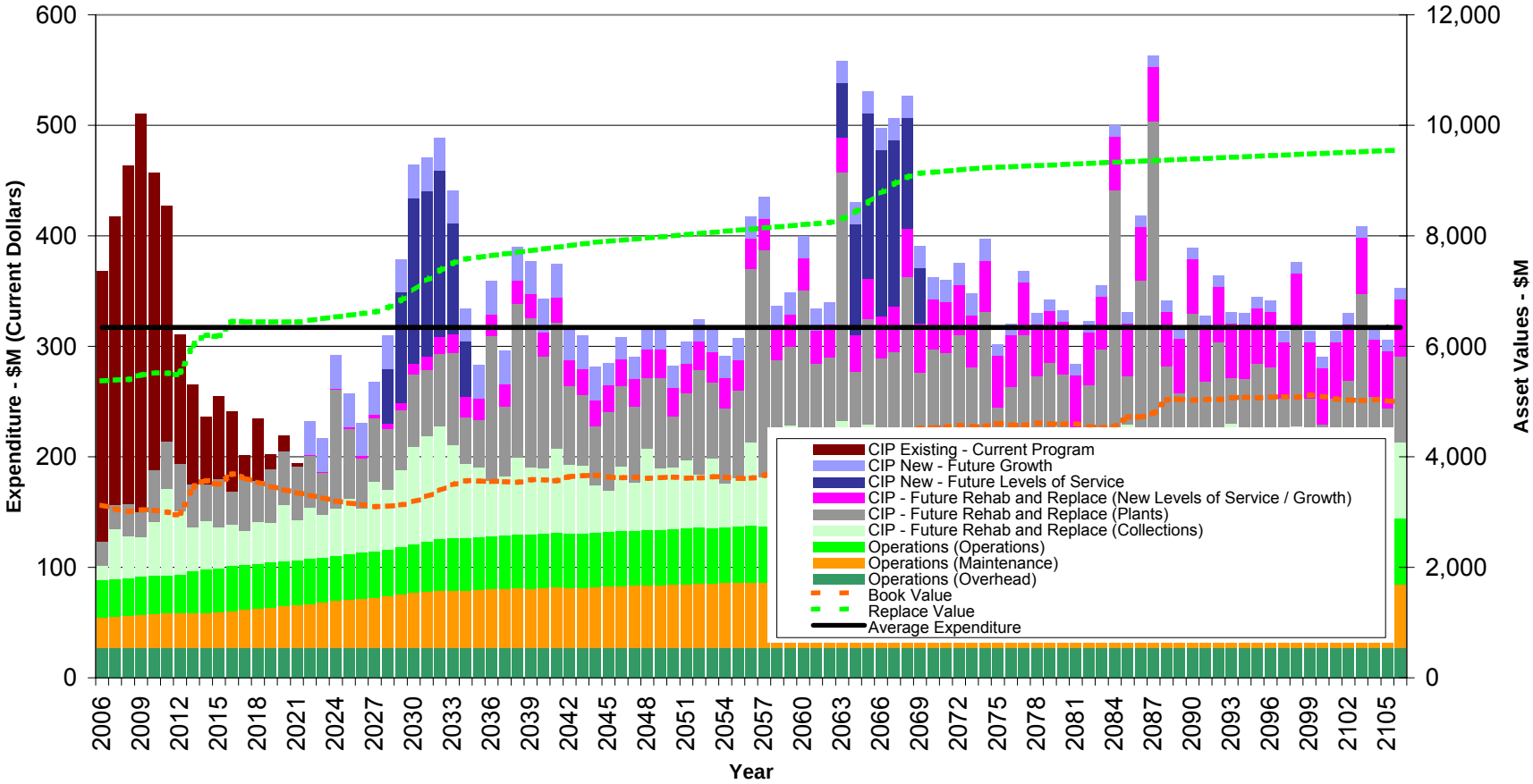
Deriving the CIP investment program – a best practice model



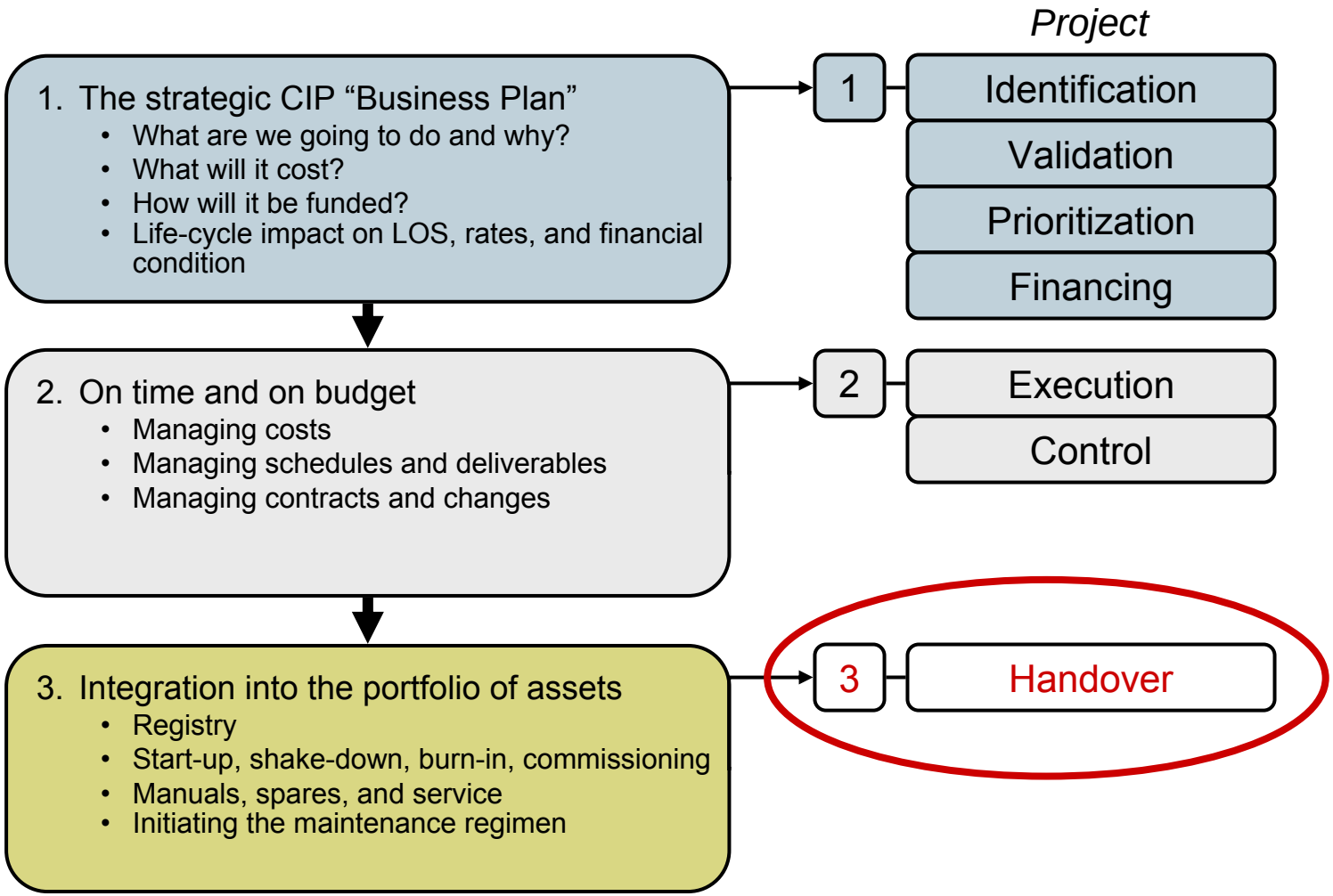
The strategic CIP financial planning model



Baseline: Projection of future life-cycle costs



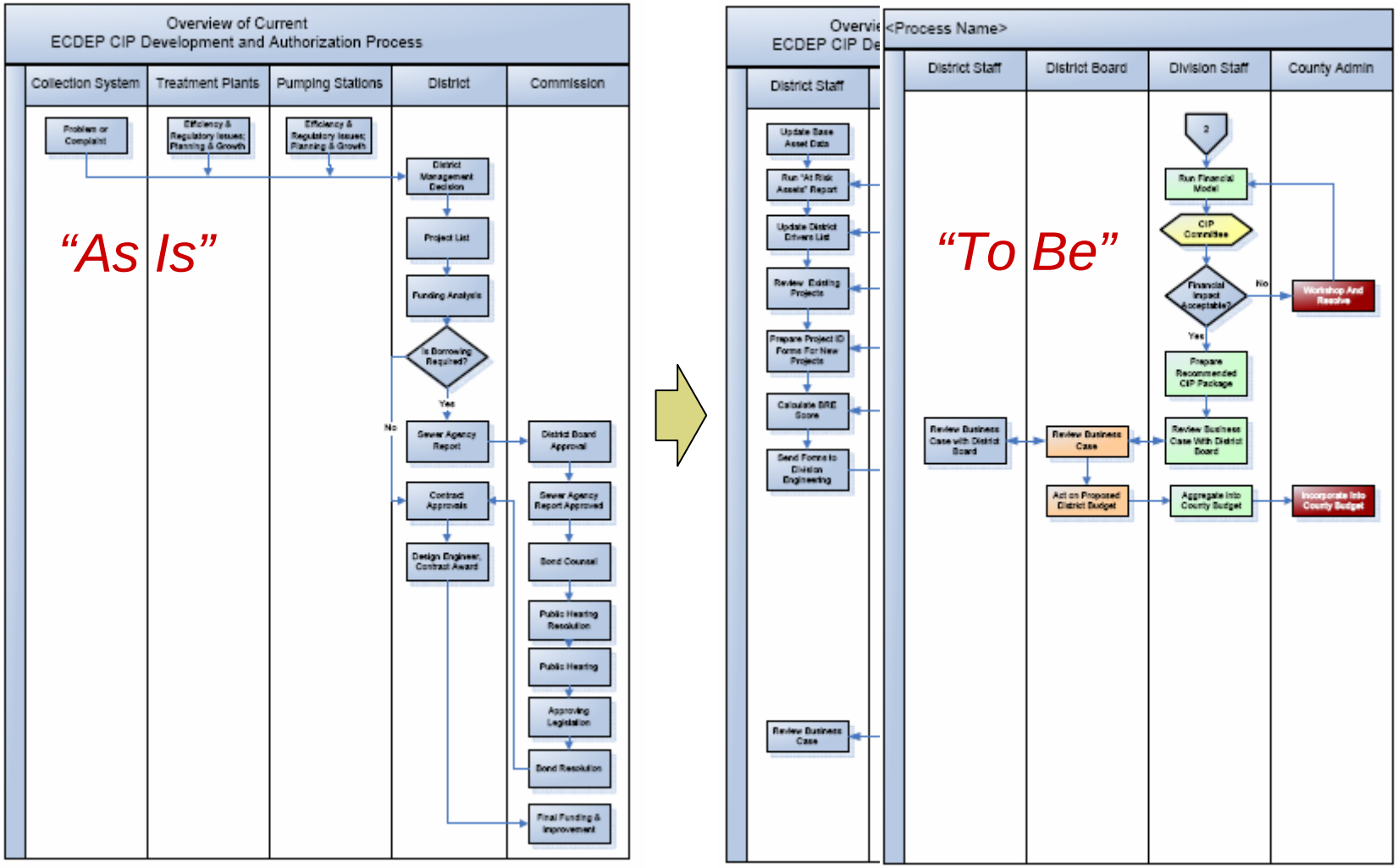
Deriving the CIP investment program – a best practice model



Project handover “best practices”

- Have contractor/vendor build asset registry at handover
  - Use retainage to assure
  - Give contractor/vendor asset registry protocol
- Collect baseline performance data after “burn-in” and store with asset ID
- Set up maintenance regimen (reactive, preventive, and predictive) at outset
- Incorporate manuals into EDMS
- Set up spares re-supply protocol

Adapt the CIP business process!



Key points from this session

Given my system, what are my best capital investment strategies?

Key Points:

- A cost-effective CIP is about the right solutions at just the right time – a balancing of demand and risk/consequence
- Review your CIP to determine the 'confidence level' you have in it – good practices plus good data lead to high confidence decisions
- Decide to proceed with or defer a given project based on the risk it represents to your agency
- For those projects you defer, undertake the necessary analysis to lift the confidence level to where you feel good about proceeding
- The quality of the CIP development process and the quality of the data available determine the level of confidence that can be assigned to the CIP
- A good CIP requires a Strategic CIP Business Plan to fit funding to projects

Associated Techniques:

- Project development and authorization
- Project identification
- CIP validation
- Project business case
- Strategic CIP Business Plan
- Business risk exposure
- Confidence level metrics

Tom's spreadsheet